Board of Scientific
Advice for India
report,
1911-12 & 1912-13

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Annual Report of the

# Board of Scientific Advice for India

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for the year 1911-12 - 也1912-13

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Annual Report of the

# Board of Scientific Advice for India

for the year 1911-12

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## Members of the Board of Scientific Advice.

| Name. | Appointment. |
|---|---|
| The Hon. Mr. E. D. Maclagan, C.S.I., I.C.S. | Secretary to the Government of India (Department of Revenue and Agriculture) and *ex-officio* President, Board of Scientific Advice. |
| G. T. Walker, Esq., C.S.I., M.A., D.Sc., F.R.S. | Director-General of Observatories. |
| N. Annandale, Esq., D.Sc., B.A., C.M.Z.S., F.A.S.B., F.L.S. | Superintendent of the Indian Museum. |
| Colonel S. G. Burrard, C.S.I., R.E., F.R.S. | Surveyor-General of India. |
| Colonel H. T. Pease, C.I.E., M.R.C.V.S. | Principal, Punjab Veterinary College. |
| Morris W. Travers, Esq., D.Sc., F.R.S. | Director of the Indian Institute of Science. |
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| B. Coventry, Esq., C.I.E. | Agricultural Adviser to the Government of India. |
| H. H. Hayden, Esq., C.I.E., B.A., B.A.I. (T.C.D.), F.G.S., F.A.S.B. | Director of the Geological Survey of India. |
| Surgeon-General the Hon'ble Sir C. P. Lukis, K.C.S.I., M.D., F.R.C.S., I.M.S. | Director-General, Indian Medical Service. |
| Major A. T. Gage, I.M.S., M.A., M.B., B.Sc., F.L.S. | Director of the Botanical Survey of India and Secretary, Board of Scientific Advice. |

## List of Sub-Committees.

**Sub-Committee A.**—(*Meteorology, Terrestrial Magnetism and cognate subjects*).

1. The Surveyor-General of India (Chairman);
2. The Director-General of Observatories;
3. The Director, Geological Survey of India.

**Sub-Committee B.**—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman);
2. *Vacant.*
3. The Inspector-General of Agriculture.

**Sub-Committee C.**—(*Soils and Manures*).

1. The Inspector-General of Agriculture (Chairman);
2. The Director, Geological Survey of India;
3. The Inspector-General of Forests.

**Sub-Committee D.**—(*Forest Products*).

1. The Inspector-General of Forests (Chairman);
2. *Vacant.*
3. The Director, Botanical Survey of India.

**Sub-Committee E.**—(*Veterinary Subjects*).

1. The Inspector-General, Civil Veterinary Department (Chairman);
2. The Inspector-General of Agriculture;
3. The Superintendent of the Indian Museum.

**Sub-Committee F.**—(*Libraries*).

1. Morris W. Travers, Esq., D.Sc., F.R.S. (Chairman);
2. The Director-General of Observatories;
3. The Surveyor-General of India;
4. The Director, Geological Survey of India.

# ANNUAL REPORT FOR 1911-12

# ANNUAL REPORT

OF THE

# BOARD OF SCIENTIFIC ADVICE FOR INDIA

1911-12

## SUMMARY OF PROCEEDINGS.

### Twenty-second Meeting held at Simla on the 13th May 1912.

The programmes of work of the various scientific departments were discussed. The Board resolved to accept the programmes as submitted, and to recommend that those departments which so far had not differentiated between more and less important investigations should in future do so and should frame their programmes accordingly. The Board also resolved that in view of the new arrangements regulating the relation of the Imperial Institute to the various scientific departments of Government, future reports on work done and programmes of work to be done at the Imperial Institute on behalf of the Government of India should be sent by the Director of the Imperial Institute direct to the Secretary to the Board of Scientific Advice to the Government of India.

It was also resolved that the individual contributions to the chapters of the Annual Report of the Board concerned with (*a*) Applied Chemistry, (*b*) Economic Botany and (*c*) Economic Entomology should be indicated by separate sub-headings.

**Twenty-third Meeting held at Dehra Dun on the 9th November 1912.**

The Board considered proposals submitted by their Secretary for securing earlier publication of the Annual Report of the Board. The Board after discussion decided that it was unnecessary to publish in future the programmes of the various scientific departments, but that programmes should be sent to the Secretary to the Board not later than the 15th April for consideration by the Board at the meeting in May and for submission to Government thereafter. It was further resolved that contributions to the Annual Report of the Board should be sent to the Secretary not later than the 1st September, for discussion by the Board at a meeting to be held in October or November.

The draft Annual Report for 1911-12 was then discussed. The Board resolved to accept the report after the omission from it of mere criticisms and expressions of individual opinion as distinct from records of fact. The Secretary was directed to request contributors to the report to append to their respective contributions a list containing the titles of such publications only as have a direct bearing on Indian conditions.

The distribution list of the Annual Report of the Board and new applications for copies were read. The Board resolved to grant the new applications and to authorise the Secretary (*a*) to distribute copies to such officers of the various agricultural departments as might apply for them, (*b*) to increase the number of copies distributed to the public press by ten copies.

The question of whether seismographic observations should be placed under the control of one department was referred by the Board to Sub-Committee A for discussion and report at the next meeting of the Board.

# APPLIED CHEMISTRY.

## PART I.—ECONOMIC AND INDUSTRIAL CHEMISTRY.

BY

D. HOOPER, F.I.C., F.C.S., F.L.S.,
*Economic Botanist, Botanical Survey of India.*

This is a review of the chemical work performed during the year apart from that undertaken by the Agricultural and Forest Departments of India. In a few educational institutions the professors and their students have prosecuted a certain amount of research not directly connected with industrial chemistry; it is considered desirable that this work should be recorded, and the titles of the papers in which such work has been published have been included in the bibliography. With the appointment of Professors of Tinctorial Chemistry at Madras and the Sibpur Engineering College, Calcutta, research should be developed in this branch of knowledge. Analyses of economic minerals are carried on by the Geological Survey and private companies, and little has been published during the year on the subject of inorganic chemistry. The present report consequently deals almost exclusively with substances of vegetable origin examined in India and Europe. Since many of these articles are consumed as food and drugs, a knowledge of their actual chemical composition is important in enabling analysts to recognise the genuine products and to detect adulteration. The report records an increased amount of analytical work in connection with economic products and substances having a possible future in the industries and commerce. The material has been arranged according to the following classification:—

1. Natural exudations: rubber, resins and gums.
2. Fixed and volatile oils.
3. Dyes and tans.
4. Fibres and paper.
5. Food substances: flour, sugars, starch.
6. Accessories to human food.
7. Drugs.

## I.—Natural Exudations.

The following notes on the examination of indigenous rubbers and resins are taken from the report of the laboratory of the Industrial Section of the Indian Museum.

**India-rubber.**—Few commercial products have been brought to light by the Abor Expedition, but a sample of rubber obtained by Mr. Burkill from the Galong Abors is of interest. The rubber is in the form of balls, weighing, on an average, half a pound. It is scrap rubber of fair quality and elasticity, and its composition, recorded below, is similar to that of *Ficus elastica* Roxb.

| | | Dry rubber. |
|---|---|---|
| Moisture | 3·2 | ... |
| Caoutchouc | 76·5 | 79·0 |
| Resins | 12·9 | 13·3 |
| Albumen | 2·6 | 2·7 |
| Ash | 4·8 | 5·0 |
| TOTAL | 100·0 | 100·0 |

The sample corresponds in analysis and appearance with some hill rubber received in 1904 from Nazira, Sibsagar.

**Ceara rubber.**—About nine years ago plants of ceara rubber (*Manihot Glaziovii* Muell.-Arg.) were planted out in farm land at Nahpa in the Northern Shan States. In three years they attained a height of 15—20 feet and girths of from 18 inches to 2 feet. Last year the trees were 2 to 3 feet in girth, and had grown vigorously. The latex was collected by tapping the trees by the herring-bone method in September, and about 2 lbs. of dry smoked rubber per tree was obtained at a cost not exceeding Re. 1 per tree. The cultivation thus promises to be very profitable in large areas such as the worked-out Taungyas at 2,400 feet

and below. A cake of the prepared rubber had the following composition:—

| | | Dry rubber. |
|---|---|---|
| Moisture | 5·20 | ... |
| Caoutchouc | 70·48 | 74·3 |
| Resins | 6·90 | 7·3 |
| Albumen | 13·62 | 14·4 |
| Ash | 3·80 | 4·0 |
| TOTAL | 100·00 | 100·0 |

This is fair average composition; the high amount of albumen is peculiar to ceara rubber.

**Euphorbia gum.**—The latex of the Euphorbias yields an inferior caoutchouc or gutta-percha, and samples are occasionally submitted for valuation. The coagulum obtained by heating the milk of *E. neriifolia* L. which had been preserved in a bottle for some years, had the following composition:—

| | | Dry. |
|---|---|---|
| Moisture | 17·30 | ... |
| Caoutchouc | 7·23 | 8·7 |
| Resins | 71·90 | 87·1 |
| Albumen | 1·87 | 2·2 |
| Ash | 1·70 | 2·0 |
| TOTAL | 100·00 | 100·0 |

A substance of this character, containing so much resinous substance, would have very little commercial value.

**Mulberry gum.**—The gum of the Indian Mulberry (*Morus indica* L.) has been noticed by a few observers, but no account of its properties or uses appears to exist in the literature of Indian products. A sample of the dried latex was received from the Tista Division in 1909.

When washed in hot water, a soft, white, plastic, gutta-like substance was left. It consisted largely of amorphous and crystalline resins soluble in alcohol according to the following proportions:—Moisture 4·7, resins 87·6, gutta 7·7.

**Calophyllum resin.**—A greenish resin is exuded by various species of *Calophyllum*, and the Indian Museum possesses two specimens from Burma and one from Madras, the production of *C. Inophyllum* L. This resin is supposed by some authorities to be East Indian Tacamahac or the "Tacamahaca orientale" of early writers, but there is no evidence that the resin is a commercial article at the present time. The resin is not known to have any industrial use, but as it is occasionally collected by the natives it is probable that they attribute to it some medicinal virtues.

The crude resin is usually mixed with pieces of bark and wood, and the purified resin is greenish, transparent and sticky, having a peculiar odour of melilot or coumarin. Two samples of the refined resin had the following constants:—Acid value, 190·9, 194·3; saponification value, 204·3, 206·7; iodine value, 148·8, 165·2.

**Mesua resin.**—The iron wood tree (*Mesua ferrea* L.) belongs to the same natural order as *Calophyllum*, and yields a resinous juice when the bark is bruised. A tenacious resin also exudes from the base of the young fruits and in time completely covers them. The resin is at first soft but hardens on exposure to the air; it is pleasantly aromatic. The soft resin had the following constants:—Acid value, 121·3; saponification value, 143·4; iodine value, 124·8. 61 per cent. of a hard brown acid resin was separated from the total; this had an acid value of 190. The unsaponifiable portion was fluid and balsamic.

**Tibetan lac.**—Dr. G. D. Hope, of the Indian Tea Association, presented to the Museum a sample of brown resin from Kalimpong having the properties of crude lac. According to Tibetans the incrustation is produced on the branches of trees of which one is "Siris" (*Albizzia Lebbek* Benth.). They boil the resin with water and prepare a red dye which they use for dyeing their clothes. The residue is pressed into cakes or sticks and sold in the bazaars. It is called "Laha" in Kalimpong, and is used for various purposes, such as fastening khukri handles and other articles. The lac is also brought in by Bhuteas to the annual cold weather fairs at Dananga and Subankhata in the north of the Kamrup district. Similar cakes are known in Manipur where they are called "Cha." The resin had the characteristics of crude lac with 10·5 per cent. of insoluble impurities.

Messrs. Hoseason and King have contributed to the Society of Chemical Industry a preliminary note on the examination of various samples of stick lac and shellac from Calcutta.

**Sterculia gum in tragacanth.**—The substitution and adulteration of powdered tragacanth with a substance known to trade as Indian gum has of late assumed large proportion, and enquiries have been made as to its occurrence. True tragacanth is a product of Turkey, Asia Minor and Persia and is exported from Beirut and the Persian Gulf ports. Mr. H. C. Fuller has shown that *Sterculia urens* Roxb. is the source of the substitute for tragacanth, and is supplied from India, where it is used in place of tragacanth in the hospitals in Bombay. The spurious article forms a nearly transparent jelly with water, and the aqueous solution is decidedly acid to litmus paper. It is unaffected by iodine solution which becomes blue in the presence of tragacanth, and it does not give a yellow colour when boiled with alkali. Indian gum reacts in a peculiar manner with borax. Tragacanth gives a smooth creamy mixture, while the substitute gives a thick slimy mass, often so gelatinous that it will not pour out of the container. Another important property of the new gum is the separation of volatile acids, largely acetic, on boiling with mineral acids. The amount of acid given off by specimens of Sterculia gum is quite constant and the acidity of a sample under examination will furnish a very reliable figure for estimating the amount present.

W. Schirmer of Strassburg has investigated the gum of *Anogeissus latifolia* Wall. and *Odina Wodier* Roxb., received from the Indian Museum, and has studied the products of their hydrolysis. Anogeissus gum contains half its weight of Arabo-galactan in which araban predominates. Odina gum contains half its weight of Arabo-galactan in which galactan predominates. Anogeissus gum yields 0·95 per cent. of nitrogen, and the Odina gum 0·78 per cent.

## II.—Fixed and Volatile Oils.

**Bassia seeds.**—Samples of these seeds were forwarded to the Imperial Institute by the Reporter on Economic Products and have been examined by Mr. R. G. Pelly. *B. butyracea* Roxb. seeds are richer in fat than those of either *B. longifolia* L. or *B. latifolia* Roxb.: *B. butyracea* yields 61·2—66·9 per cent.; *B. longifolia* 55·3—57·8 per cent.; and *B. latifolia* 33·0—46·0 per cent. of fat.

The fats of *B. longifolia* and *B. latifolia* are of similar character, but they differ widely from the fat of *B. butyracea*. This is confirmed

by the results of the investigation of the fatty acids, which, stated briefly, are as follows. The fats of *B. longifolia* and *B. latifolia* consist of glycerides of stearic, palmitic and oleic acids, and in the case of *B. longifolia* of linoleic acid, whilst the fat of *B. butyracea* contains glycerides of palmitic and oleic acids only. The fat of *B. butyracea* is of firmer consistence, and this fact, together with the superior yield obtainable, indicates that the seeds of this species are of greater value than those of other species if it is found that supplies can be obtained in sufficient quantity for the European market.

**Marotti fat.**—In 1911 it was recorded that several poisoning cases had occurred in Germany through the consumption of margarine made from "Marotti" or Maratti" fat or "Cardamom" oil imported from India. An investigation made at the Hamburg Hygienic Institute showed that the fat is very similar to that yielded by *Hydnocarpus Wightiana* Bl. and *H. venenata* Gaertn. of South India and by *Taraktogenos Kurzii* King, the Chaulmugra of North-East India. This discovery has been the subject of numerous reports and enquiries. All these fats contain chaulmoogric and hydnocarpic acids, which are now shown to be physiologically active, causing nausea and vomiting and producing irritation of the mucous membrane of the stomach.

**Gynocardia oil.**—The rancidity, judged by the high acid value of commercial samples of Chaulmugra oil, is attributable to the decomposed state of the seeds before they are pressed. A much superior oil, it is presumed, would be obtained from fresh seeds or seeds preserved after careful drying. In order to test the property of the oil from newly collected and carefully picked seeds, some seeds of *Gynocardia odorata* Br. or False Chaulmugra were forwarded by Mr. Burkill from Kobo, the base of the Abor Expeditionary Force.* The acid value of the ether extracted oil was 3·23, that of the expressed oil 3·09. We may compare these figures with those of Power and Barrowcliff obtained on the oil of the same seeds collected in the ordinary way and examined after a long sea voyage. The determinations recorded are—Acid value of ether extracted oil, 5·0; expressed oil, 4·9. The acid values of the oil of the fresh seeds are not much below those determined in England, but they are lower than all the published acid values of Chaulmugra oil of commerce, and the results tend to prove the desirability of using seeds fresh as possible for oil extraction.

**Chilgoza nuts.**—The seeds of Chilgoza or Neoza pine (*Pinus Gerardiana* Wall.) form one of the great trade products exported from the district of Khost and the Kuram Valley to India. Large quantities also

pass through Leh to Yarkhand and Lhassa. They are sold all over Northern India, and are available in the Calcutta market in the dry weather. The nuts form a nutritious article of food, and the oil is sometimes expressed and used for edible purposes. The nuts contain about half their weight of oil which is almost neutral in reaction and possesses slightly drying properties.

**Thevetia seeds and oil.**—Under the name of "Kaneer" the Chemical Examiner of the United Provinces forwarded some seeds which had been used in cattle poisoning. They were identified as the seeds of the yellow Oleander (*Thevetia nereifolia* Juss.). All parts of the plant are known to be poisonous, and the active principle, thevetin, has been shown to resemble digitalis in its action. In addition to their morphological characters the seeds are easily distinguished by giving a blue colour with hydrochloric acid.

The seeds are very oleaginous, and a sample from Dacca had the following composition:—

| | |
|---|---|
| Moisture | 3·5 |
| Oil | 59·8 |
| Albuminoids | 16·5 |
| Carbohydrates | 17·1 |
| Fibre | ·4 |
| Ash | 2·7 |
| TOTAL | 100·0 |

The oil is perfectly liquid at ordinary temperatures and has a specific gravity of 0·9148 at 25° C. Oudemans found it to consist of 63 per cent. triolein and 27 per cent. tripalmitin and tristearin.

**Prinsepia utilis** Royle.—The seeds of this shrub, known as "Bhekul," yield an oil by expression which is used in the North-West Himalaya for food, illuminating, and occasionally in medicine. It is said to be exported in small quantities from the forests of Garhwal and Kumaon. There are two samples in the Indian Museum: one from the Kangra Valley, of a bright green colour, and the other from Bushahr in the Punjab, opaque and light brown in colour. In specific gravity, iodine value and melting point of the insoluble fatty acids, the oil resembled that derived from cotton seed.

An Agricultural Ledger on fixed oils has been published during the year by Mr. Hooper. It deals with the sources, properties, uses and value of vegetable fats and oils available in British India.

**Cinnamomum glanduliferum** Meissn.—The "Nepal Sassafras" or "Nepal Camphor" occurs as a large tree in Assam, where it is called "Gonserai." The oil of the wood examined by Mr. S. S. Pickles is pale yellow and possesses an odour resembling safrole. The yield obtained from the dried ground wood by steam distillation was 4·16 per cent. An exhaustive examination showed the oil to consist mainly of safrole, myristicin and elemicin. Other constituents present in small quantities are palmitic acid, esters of the lower fatty acids and traces of phenols.

**Cinnamomum Parthenoxylon** Meissn.—This yields the Martaban camphor wood or Selasian wood. An oil distilled from the chips at Buitenzorg gave the following constants:—Density 1·067, optical rotation – 1° 3′, saponification value 8·4, ester value after acetylation 11·8.

**Meriandra bengalensis** Benth.—The leaves of this labiate plant are used in Eritrea as a popular remedy for similar purposes as those of sage, and the oil bears some resemblance to sage oil. The raw material yields 1·5 per cent. of a pale brown oil with an odour of sage and rosemary. The density was 0·9513, acid value 3·7 and ester value 14·8. It was soluble in two volumes and more of 70 per cent. alcohol. Placed in a freezing mixture or submitted to fractional distillation dextrorotatory camphor was separated.

**Ocimum sanctum** Linn.—The statement that the oil of the Holy Basil of India contains methylchavacol has been confirmed. Brooks, who has recently investigated the product in the Philippines, found between 50 and 60 per cent. of methylchavacol, besides cineole and linalool.

**Strobilanthes lupulinus** Nees.—A fragrant acanthaceous shrub very common on the ghats near Bombay is collected for its perfume. The oil distilled from the flower buds possesses a very strong and pleasant odour. The constants are: Density 0·9648, optical rotation 16° 30′, saponification value 1·7, and ester value 25·7.

**Indian turpentine oil.**—In continuation of the remarks made on this oil in last year's report, Mr. H. H. Robinson has examined by fractional distillation and analysis genuine samples of the oil of *Pinus longifolia*. One fraction, amounting to about one-third of the whole, was of a much lower boiling point and was found to be l-pinene. From the remaining two-thirds sylvestrene was obtained as a hydrochloride. It is thought very possible that the sylvestrene is not present as such in the original oil, but that a terpene is there contained which unites with hydrogen chloride to form sylvestrene dihydrochloride, just as pinene

yields a hydrochloride from which camphene is obtained when the hydrogen chloride is removed.

**Toddalia aculeata** Pers.—A camphor-like compound melting at 96·5° to 97° has been obtained by Mr. B. T. Brooks from the oil. The leaves yield ·08 per cent. of oil by steam distillation. On freezing, the oil deposited 18 per cent. of a white crystalline compound, very volatile, and having an odour closely resembling that of camphor. The oil had an odour suggesting a mixture of camphor and lemon grass. Sp. gr. at 20°, 0·9059. The oil is largely linalool, since the fraction between 195° to 200° yielded citral on oxidation with chromic acid mixture.

**Indian Wintergreen oil.**—The parent plant of this oil is *Gaultheria fragrantissima* Wall., a bush occurring gregariously over tracts of the Nilgiri Hills and the Palni and Travancore Hills. It differs markedly from the American Wintergreen (*G. procumbens* L.) which is a small creeping shrub. The oil consists chiefly of methylsalicylate, and that distilled locally is wholly restricted to home consumption. It would, however, be possible to extend the industry seeing that there is abundance of the raw material available.

## III.—Dyes and Tans.

**Cedrela Toona** Roxb.—These flowers which constitute an Indian dyestuff of minor importance yield, according to Mr. A. G. Perkin of Leeds, a minute amount of a red colouring matter identical with the nyctanthin obtained by Hill in 1907 from the flowers of *Nyctanthes Arbor-tristis*. This melts at 285—287°. In dyeing and other properties it closely resembles, but is not identical with, the bixin of annatto (*Bixa Orellana*). The presence of quercetin contaminated with a trace of an allied colouring matter as glucoside and of a sugar have also been detected, and to the former the main dyeing properties of the flowers appear to be due.

**Red Sandal Wood.**—Santalin, the colouring principle of Red Sandal Wood (*Pterocarpus santalinus* Linn. f.), has been examined by Messrs. Cain and Simonsen. Santalin is a red micro-crystalline powder melting at 276°, and having the formula $C_{15}H_{14}O_5$. It contains a methoxy and two hydroxy groups. With hydroxylamine it forms an oxime, and on oxidation with potassium permanganate yields veratric and anisic acids. The authors isolated a colourless glucoside from the sap of the plant, from which santalin is probably produced in the plant by the action of an oxidase.

**Assam dye wood.**—The root of the "Napoo" (*Fibraurea Trotteri* Watt), an extensive climber common in the forests of Manipur, is used as a yellow dye in Assam. The root is soaked in water, cloth is steeped in the infusion for twenty-four hours, and the colour is fixed by means of the fruits of "Heibong" (*Garcinia pedunculata* Roxb.). An authentic sample of the root was analysed and found to contain 1·89 per cent. of the alkaloid, berberine.

**Mangrove bark.**—A large quantity of the wood of the "Goran" (*Ceriops Candolleana* Arn.) is brought from the Sunderbans into Calcutta for fuel. The bark is a valuable tanning material, but it is said to vary according to the age of the tree from which it is taken. In order to determine the distribution of tannin in the older and younger bark, a tree about 12 feet in height was cut down and divided equally into four parts, the first representing the thicker and older bark at the base of the stem, and the fourth representing the thinner and younger bark at the top. The bark from each portion was separately dried and analysed with the following results:—

| —— | Moisture. | Ash. | Extract. | Tannin. |
|---|---|---|---|---|
| No. 1 | 11·3 | 9·5 | 37·2 | 26·2 |
| No. 2 | 11·0 | 9·0 | 36·7 | 24·6 |
| No. 3 | 10·5 | 8·8 | 35·4 | 23·8 |
| No. 4 | 10·5 | 8·9 | 34·7 | 22·8 |

This experiment exemplifies the greater tanning value of the older and thicker bark of the mangrove tree compared with the younger portion.

## IV.—Fibres.

**Rhea.**—At least two processes for cleaning rhea fibre (*Boehmeria nivea* Hook. & Arn.) in India have been devised during the year. A Calcutta merchant submitted samples along with samples of the fibre prepared in Germany for favour of comparison with that prepared locally. In appearance they were equally good and in strength they were about the same. On testing them by chemical methods, there was found to be a very little difference in their composition. A cheap and suitable plant for cleaning the fibre on a large scale is still desirable.

**Hental leaves.**—An enquiry has again been made as to the value of the leaves of "Hental" (*Phœnix paludosa* Roxb.), the wild date palm of the Sunderbans. The leaves contained 28·6 per cent. of cellulose. Some years ago a large quantity of the leaves was sent to a paper mill

for experiment, and the manager reported that the yield of fibre was only 25 per cent., and the material was therefore too expensive to use.

The bark of "Bhola" (*Hibiscus tiliaceus* L.), a plant of the Sunderbans, yielded 30 per cent. of fibre. The bark of *Sterculia villosa* Roxb. affords 49·85 per cent., a much better return.

## V.—Food Substances.

**Amorphophallus tubers.**—The corms or tubers of *Amorphophallus campanulatus* Bl. are cultivated throughout India in rich moist soils. In Bengal the plants are known as "Ol," and the roots, containing much starch, are considered nutritious and wholesome, and are cooked like potatoes by boiling or roasting. The wild roots are acrid and irritating, which property is removed by thorough washing and boiling. The acrid principle is partly, if not entirely, due to the presence of needle-shaped crystals or raphides, which causes troublesome irritation in the mouth and fauces. Four samples of fresh tubers of the following descriptions were analysed to ascertain their nutritive value:—

(1) "Deshi Ol," cultivated, with fingers; (2) "Chit Ol," a wild small tuber; (3) "Deshi Ol," large, cultivated; (4) "Bombai Ol," large, cultivated.

The dried and powered tubers contained from 0·7 to 1·2 per cent. of fat, 6·7 to 9·6 per cent. of albuminoids, 80·3 to 85 per cent. of carbohydrates, 2 to 3·8 per cent. of fibre, 4·7 to 7·5 per cent. of ash, and 0·55 to 0·75 per cent. of phosphoric anhydride.

The samples were examined microspically and raphides were found most abundant in the wild variety (No 2) containing the largest amount of ash. The largest quantity of lime as acid soluble ash was also present in this tuber.

**Bamboo seed.**—Owing to the phenomenal flowering last May of the Muli bamboo (*Melocanna bambusoides* Trin.), in Assam, the large pear-shaped fruits have attracted attention. Dr. Stapf has described the fruit in the Trans. Linnean Society, 1901-5, VI, 409. They are said to be edible, but no chemical analysis has so far been made of them. A sample was sent by Messrs. Shaw, Wallace & Co. from one of their estates in Sylhet. The edible portion or seed is quite palatable and had the following percentage composition:—

Moisture 10·20, fat ·65, albuminoids 14·62, carbohydrates 65·23, fibre 1·40, ash 7·90, phosphoric anhydride ·69.

**Salep.**—There being very few recorded analyses of salep, the dried corms or tubers of species of orchids, a sample of the large ovoid roots obtained from Lahore bazaar in 1908 was examined. The powder had the following composition:—

Moisture 9·65, albuminoids 8·62, carbohydrates 77·73, fibre 1·15, ash 2·85, phosphoric anhydride ·56.

## VI.– Accessories to Human Food.

**Tea.**—Dr. G. D. Hope and his assistants have continued their investigations into the various problems affecting the tea industry, and the results have been published in special reports and in the new Quarterly Journal of the Scientific Department. In a paper on the "Firing of Tea" (No. 1 of 1911 of the Indian Tea Association) Messrs. Hope and Carpenter describe the results of experiments carried out at the Heeleaka Experimental Station. Changes in the amount of tannin, total soluble matter and oxidisable volatile matter in the leaf as the result of firing under different conditions are recorded, and the inference is drawn from the indications afforded by the experiments that it is most detrimental to the successful retention of essential oil, tannin and total solids to fire it at a high temperature during the early stages of the process, particularly if the leaf is surrounded during that time by an atmosphere highly saturated with water vapour. It appears more desirable to effect the drying in as short a time at a lower temperature by means of an increased air draught and the leaf thinly spread on the trays of the machine. There are indications of chemical changes taking place at the later stages of, and after firing, which may profoundly influence the flavour of the product.

In the second Quarterly Journal of the Department there is an interesting article on caffeine, describing the distribution of the alkaloid in the organs of the tea plant, the amount present in teas of various kinds and the combination of caffeine and tannin in the infusion.

**Abor tea.**—In May last Mr. A. J. Harrison of Dibrugarh, Assam, sent to the Indian Museum some specimens of leaves which the Abors call tea, and from which they make an excellent drink. The plant is about 5 feet high, and grows near the villages. The plant has been identified as *Actephila excelsa* Muell., a plant of the *Euphorbia* family. The leaves contain no alkaloid and are without any special aroma. They are extremely mucilaginous. A small quantity of tannin was present

and a white crystalline neutral principle. They would appear to constitute a harmless drink.

**Bee-food.**—The flowers of certain species of *Strobilanthes* growing in the Bombay Presidency and in Burma are visited by the large Indian bee (*Apis dorsata*) for collecting honey and wax. The flowers are aromatic, and the sticky sweetly scented buds of *S. ixiocephalus* Benth. are sent to Bombay from Kathiawar as a perfume. Some of the dried flower heads of *S. foliosus* T. Anders. were sent to the Museum for examination, to ascertain if the resin could be put to any commercial use. In addition to 9 per cent. of a fragrant oleo-resin, the heads afforded 3·18 per cent. of wax and 0·5 per cent. of sugar. The wax and sugar, no doubt, contribute largely to the bee-food found in the jungles in the Bombay Presidency.

**Alcohol.**—Mr. R. L. Jenks, formerly of the Central Excise Laboratory, Kasauli, has in the press a report on the method of spirit valuation for revenue purposes, and has devised a suitable pycnometer for taking the specific gravity of alcohol in the tropics at 60° F.

## VII.—Medicinal Products.

**Camelthorn root.**—A sample of the root of camelthorn (*Alhagi camelorum* Fisch.) was sent from Cawnpore to the Indigenous Drugs Committee for examination and report, it having been pronounced to be a specific in malaria. The root contained a wax, resin, tannin, tannin anhydride, organic acid, sugar, quercetin, and colouring and mucilaginous matters. It yielded no alkaloid. Its properties being mildly astringent, the root would appear to have no recommendation as a febrifuge.

**Belladonna leaves.**—The acclimatisation of medicinal plants is a subject worthy of further study in this country. It is intended to prepare a statement of those that are cultivated for the Medical Stores and compare their composition with plants grown in Europe. A sample of leaves of *Atropa Belladonna* L. grown in Kashmir and sold by a Calcutta druggist was sent for valuation. The leaves contained 0·27 per cent. of alkaloid, an average yield compared with the European drug.

**Belladonna root.**—The Superintendent of the Kumaon Government Gardens forwarded for opinion the roots of Belladonna plants grown at Jeolikote—No. 1 sample was from one-year old plants, and No. 2 sample was from two-year old plants. They afforded respectively 0·40 and 0·45 per cent. of alkaloid. A sample from Kashmir also gave 0·45 per cent. The valuation of European root is from 0·2 to 0·6 per cent. of

alkaloid; the cultivated Indian root is, therefore, of average medicinal quality.

**Coptis root.**—The two sources of this root procurable in India are the Mishmi Teeta from the Mishmi Hills, north-east of Assam, and the root imported in Bombay from Japan. The former is considered a superior drug and commands a higher value in the market. A description of the two kinds known in this country and the result of their comparative analysis has been published as a supplement to Mr. Burkill's work on the botany of *Coptis*.

**Croton bark.**—It has been reported that the bark of *Croton Tiglium* L. is one of the ingredients of the Abor arrow poison. The bark is intensely acrid, and when applied to the arm in a fresh state it causes irritation and raises pustules. Two preparations were made from the bark, one a watery extract, and the other an alcoholic extract. The extracts were examined by Major J. W. D. Megaw, I.M.S., of the Medical College, Calcutta, with a view to finding the minimum lethal dose on guinea-pigs. 0·63 gram of the watery extract inserted in a pocket under the skin produced marked local irritant symptoms and caused death in five days. 0·2 gram of the alcoholic extract injected subcutaneously caused death in four hours. 0·1 gram caused death in 28 hours. Both cases were attended with marked local irritation. The extracts are of a comparatively low degree of toxicity for guinea-pigs, but the experiments prove that the fresh bark contains a poison of distinctly virulent type.

**Gardenia gum.**—The Deputy Conservator of Forests, Ramnagar, Garhwal Division, United Provinces, sent last June some samples of a white incrustation taken from trees of *Gardenia turgida* Roxb. The exudation occurred after longitudinal cuts had been made in the upper part of the stem, and did not form at the base of the tree. The gum was white, brittle and sweetish to the taste, and on testing its solubility and melting point it was found to contain mannite. The occurrence of manna in this genus is remarkable since other species of *Gardenia* are known to yield a yellow fragrant resin, called Dikamali resin.

**Ginger.**—In testing some samples of cultivated ginger root it was necessary to traverse the statement made by S. J. Riegel in 1891 that East Indian ginger yields 8 per cent. of oleo-resin, and that Jamaica ginger contains about 5 per cent. It was found that on estimating the pungent resinous principle by means of alcohol, either of 90 per cent. strength or absolute, the dried extract contained sugar and other matters soluble in water. The amount of washed oleo-resin would therefore be a more accurate criterion of the value of the root. A few Museum samples,

and recently dried samples from the local market, were extracted with strong alcohol, and the extracts washed with water. The following results were obtained:—

| | Alcoholic extract. | Washed resin. |
|---|---|---|
| Punjab | 11·1 | 8·1 |
| Rough, Calicut | 9·3 | 7·0 |
| Bleached, Calicut | 6·0 | 4·0 |
| Unbleached, Calcutta | 5·7 | 5·1 |
| Bleached, Calcutta | 5·1 | 4·3 |
| Freshly dried, Geoukhali | 8·4 | 3·9 |
| „ „ Hooghly | 7·9 | 4·3 |
| „ „ Rungpur | 11·8 | 5·1 |
| „ „ „ | 9·3 | 4·7 |

From these few examinations there is seen to be a great variation both in the amount of extract and oleo-resin. The freshly dried samples also contain a smaller proportion of resin in the extract than the Museum samples of dried ginger.

An interesting experiment was made in the Kumaon Government Gardens to ascertain if ginger increased in value by being left longer in the ground. The root is usually harvested in December, and for purposes of the trial a sample was collected that month, another portion of the crop was lifted in February, and a sample of the original "Soont" from which the younger roots had grown was also taken. These were analysed:—

| | Harvested in December 1911. | Harvested in February 1912. | Original "Soont." |
|---|---|---|---|
| Extract | 6·4 | 8·3 | 14·0 |
| Washed resin | 3·0 | 3·5 | 4·1 |
| Ash | 6·5 | 6·8 | 7·2 |
| Moisture | 11·1 | 10·4 | 9·7 |

These results demonstrate that young ginger develops more oleo-resin the longer it is allowed to grow.

**Saffron.**—The Revenue Commissioner in Baluchistan forwarded during the year to the Reporter on Economic Products a sample of stigmas and anthers of *Crocus sativus* L. cultivated experimentally in Quetta. The stigmas, which constitute the true saffron of commerce, were of excellent quality, both in aroma and tinctorial properties.

**Indian blistering beetles.**—*Mylabris cichorii* Fabr. and other species of this beetle have been used for many years as a substitute for European cantharides, and are official in the Indian and Colonial addendum to the British Pharmacopœia. The beetles are collected for commercial purposes at Gwalior, and are supplied to all the Medical Store Depôts. K. Dieterich in 1901 found these beetles to contain from 0·73 to 1·92 per cent. of cantharidin, while the Spanish flies yielded on an average 0·7 per cent. Eldred and Bartholomew in 1908 recorded the occurrence of 1·24 and 1·36 per cent. in Mylabrideæ. During the year samples have been obtained from the principal Medical Store Depôts and submitted to analysis. The following figures were obtained:—

| —— | Cantheridin. | Ash. | Moisture. |
|---|---|---|---|
| Calcutta . . . . . | 1·47 | 8·7 | 11·0 |
| Bombay . . . . . | 1·02 | 5·7 | 10·2 |
| Lahore . . . . . | 1·26 | 5·3 | 7·7 |
| Madras . . . . . | 1·12 | 7·2 | 10·5 |

This result is satisfactory in showing that the drug used in India contains over 1 per cent. of cantharidin. The dried beetles do not appear to lose their active principle on being stored. The sample from Calcutta was marked as "old stock, 1910," yet it contained the largest amount of active principle.

There is evidence that the amount of vesicating principle depends upon the species of beetle employed. A sample of *Cantharis hirticornis* from the Murree Hills, Punjab, yielded as much as 2·02 per cent. of cantharidin.

**Indian hemp.**—Messrs. C. R. Marshall and J. K. Wood have submitted to the Therapeutic Sub-Committee of the British Medical Association a report on the standardisation of Indian hemp (*Cannabis sativa* L.). This is an investigation of the value of the acetyl number

which a previous research had indicated as likely to offer the basis of a chemical and physical standard. Many acetyl numbers were determined, but it was found that there is a marked divergence between the pharmacological activity and the acetyl number which indicates that this method, like the iodine value reported on last year, cannot be used as a substitute for physiological standardisation.

**Ægle Marmelos** Corr.—Mr. J. C. Shenstone has recorded the interesting observation that bael fruit contains starch granules of a peculiar shape. It is unusual to find starch in a fruit which develops rapidly to ripeness and then decays. The starch may be deposited to provide nourishment for the fruit in the final effort of ripening.

**Andrographis paniculata** Nees.—By extracting the leaves of this bitter medicinal plant with alcohol, M. K. Gorter has isolated a lactone, $C_{20}H_{30}O_5$, named andrographolide. It is converted into salts of andrographolic acid by boiling with caustic alkalis.

**Cæsalpinia Bonducella** Fleming.—The seeds yield an alkaloid for which Babu K. Bhaduri suggests the name "natin." The oil has a density at 27° of 0·9132, iodine value 96·1, and saponification value 292·8.

**Cinchona.**—During the past year in the Bengal Cinchona Plantations 853,638 lbs. of bark were worked up in the factory and yielded 48,393 lbs. of sulphate of quinine and other products. The plantation-grown bark yielded 3·4 per cent. of quinine and the imported Java bark yielded 5·7 per cent. To obtain a rough idea of the future yield of the Munsong Cinchona, 27 trees gave 324 lbs. of dry bark, equal to 12 lbs. per tree. The stem bark yielded 5·25 per cent., root bark 4·92 per cent. and branch bark 2·89 per cent. of sulphate of quinine or an average of 4·71 per cent.

In the Madras Cinchona Plantations in the Nilgiris 755,900 lbs. of bark were worked up in the factory and yielded 30,489 lbs. of quinine sulphate or 4·03 per cent. against 3·63 per cent. in the previous year.

In connection with this subject a translation has been published in the form of an Agricultural Ledger of Dr. K. W. Van Gorkom's administration of the Java Cinchona Estates during the period from 1872 to 1907.

**Daturas.**—Mr. A. E. Andrews has studied the active constituents of Indian solanaceous plants. It was found that in *Datura Stramonium* L. the percentage of total alkaloid in the stems was 0·25; in the leaves 0·41 and 0·45; and in the fruits 0·46; with one exception this alkaloid consisted of hyoscyamine either alone or associated with a small proportion of scopolamine. The results indicate that the Indian plant bears

favourable comparison with the European and Egyptian plants as regards the amount of total alkaloid, but the presence of scopolamine in some of the Indian samples appears to be a point of difference.

In *D. fastuosa* L. the total alkaloid varied from 0·1 in the roots to 0·2 in the fruits, and scopolamine was found to be the predominant alkaloid. In these respects the Indian plant closely resembles the European plant.

In *D. Metel* L. the seeds and the leaves contained 0·25, and the capsules 0·12 per cent. of total alkaloid. On comparing the results with those recorded for the European species it appears that in the Indian plant the amount of total alkaloid in the seeds and in the leaves is only about one-half what it is in the European plant, but with one exception the samples resemble the latter in so far that scopolamine is almost unaccompanied by other mydriatic alkaloids.

**Nerium Oleander** L.—Further investigations by A. Leutier confirm the existence in all parts of the plant, except in the latex, of the glucoside previously reported. This is probably the substance named "neriin" by Schmiedeberg who examined the plant in 1883 and isolated, besides this, the alkaloid oleandrine, and another glucoside, neriatin. On account of its strong affinity to strophanthin, neriin is now re-named "laevostrophanthin." A solution of a few crystals of the glucoside in strong sulphuric acid is coloured violet by contact with bromine vapour or nitric fumes. It is very poisonous, the toxic dose ranging from 2 to 6 mgm. per kilo for the dog. The latex contains another distinct crystalline glucoside.

**Vernonia anthelmintica** Willd.—The seeds contain a glucoside to which Babu K. Bhaduri has assigned the name "Shomerajin." The oil has density at 25° of 0·9731, iodine value 91·7, saponification value 305·7.

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## PART II.—AGRICULTURAL CHEMISTRY.

BY

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**Usar Soil.**—A long investigation which has been in progress in collaboration with officers of the Agricultural and Irrigation Departments for several years was brought to a conclusion during the past year. In the

United Provinces "alkali spots" occur in cultivated lands over a very large area. These spots are more or less infertile, frequently quite sterile, patches of land of a few square yards in area. Sometimes they lie so close to the margin of an usar plain that the relationship of the one to the other is apparent, but often such connection is absent. They occur alike within canal-irrigated and well-irrigated lands. Sometimes complaints are made that an extension of these alkali spots has occurred and it was due to such a case of complaint that the series of investigations now referred to were instituted.[1]

The first questions raised were to what extent do the usar salts move either vertically during changes of season, or laterally. It has been generally accepted as an established fact that the obnoxious soda salts of alkali lands are brought to the surface by the evaporating water during dry weather and are carried into the sub-soil during wet weather; that in fact such a movement is not only to be expected on theoretical grounds, but that such a periodical displacement applies to a large proportion of the saline ingredients in the soil. It is also certain that such salts will spread laterally into any soil which contains a less quantity, not that there is necessarily any movement of water, but the laws of diffusion of salts demand that this must be so.

But whilst the principles involved are readily defined, the practical effect on the land will depend on the amount of such movement in a given time. If it is great, as writers on alkali soils usually depict, the effect will be marked; on the other hand it may be so small as to be of no importance.

The tests which were made in order to estimate the amount of such movement of salts were carried out in the Mainpuri District near Bhadan by the late Babu Subodh Chandra Kar, second assistant to the Imperial Agricultural Chemist, under instructions from Mr. B. C. Burt and Dr. Leather, and the results went to show that the variation at any one time in the quantity of these salts from point to point in a horizontal plane in the soil was so great that it would only be possible to detect a seasonal movement of salts if this were considerable. The tests were conducted over a whole cold-hot weather season, November 1909 to May 1910, and necessitated the examination of the soil at each succeeding 6 inches from the surface down to either the water-level or to 9 ft. It was shown that no measurable movement of the alkali salts occurred in these soils towards the surface during the dry season. There was also no indication of any

[1] See "Investigations on usar land in the United Provinces" (*in the press*).

saline layer, so often spoken of as a characteristic of alkali lands in general, in the sub-soils at any time. The salts included the very destructive sodium carbonate, and bicarbonate, together with generally smaller amounts of chloride and sulphate; the amount of alkali though small was sufficient to account for the infertility of the soil. Records of the amount of water present throughout the season showed that there was a far smaller loss of this constituent than would occur in good arable land.

These soils were at the same time examined with regard to another characteristic, namely, their permeability to water, or the rate at which water moves through them. It was known in a general way that many of these alkali soils are much less permeable to water than ordinary agricultural land, but for the end in view a quantitative measurement became essential. There being no recognised method of making such a measurement, a new test had to be devised. This was done at the Pusa laboratories. The test consisted in first packing the soil into cylinders fitted with a "false" bottom by the aid of a specially designed machine, and then allowing water to percolate through it. It proved of the utmost service and showed that the permeability of these alkali soils to water was far less, one-hundredth or one-thousandth part, than in good arable soil.

This feature of the soil provided the true explanation of the facts which had been observed in regard to the salts. The movement of the salts is dependent, excepting in respect of diffusion, on the movement of water through the soil. If this is small, so will be the amount of salts which can move through a given stratum of soil in a given time. The soils were in fact so highly impervious to water that there could be no material movement either downwards during wet weather or upwards during the dry season, and there was consequently no "saline sub-soil layer" during the monsoon, nor accumulation of salts on the surface in the hot weather. The *appearance* of these lands gives the impression that such changes do occur, because in dry weather the salts dry on the surface and become visible, but in point of fact they are merely carried by rain about an inch or so into the soil where they remain practically stationary until the dry season sets in.

Subsequently to the above-mentioned investigation, a large number of alkali spots were examined (1910-11) through a stretch of about 20 miles of country in the Muttra and Etah Districts with a view to ascertain whether any difference exists in the nature of these alkali spots in well-irrigated and canal-irrigated tracts respectively. The first 10 miles

consists of country which has never been canal-irrigated but always well-irrigated; the second 10 miles has been under canal-irrigation for many years. In addition to general appearances and the character of the crops, samples of the soils were drawn, as had been done in Mainpuri District, for each succeeding six inches from the surface down to 9 ft. and examined with respect to the nature and amount of salts present and their physical properties. The results showed very conclusively that there is no difference between these alkali spots which are found under the two systems of irrigation; in every respect they were similar. They are not therefore the creation of canal-irrigation. They consist of "blocks" of an irregular shape both below and on the land surface; in superficial area they measure a few square yards, in depth rarely more than 9 ft. but usually more than 5 ft.; the side is often apparently nearly vertical but also commonly slopes away; nodular kankar frequently occurs in them but is probably not a necessary constituent, since it was apparently absent in some cases. The soil is highly impervious to water; the amount of salts is usually small, but the pernicious sodium carbonate is always present. No ordinary system of drainage could hope to affect such soil. Approximate calculation showed that if 2 ft. depth of water were constantly maintained on the surface of such land, the time required for it to percolate through 5 ft. would be from 6 months to 5 years according to the exact nature of the land.

The experiments which have been in progress on usar land at Aligarh for a long time were also examined. There the land is a compact alkali plain, the soil of which has the same general chemical and physical characteristics as have been described above, though the depth of the impervious soil is often only small, such as 3 to 4 ft. The imperviousness explains much of the small success which has attended these experiments. For example the salts had been regularly scraped off the surface of one plot for nine years, until but little saline matter accumulates on the surface soil during the hot weather. The land is however still quite sterile and the analysis showed that it contains in the sub-soil practically as much salts as it did formerly. The effect of the annual scraping has been to remove that portion of the salt which was always quite near the surface and which could be brought up annually by the evaporating water, but the greater part of the salts lies too far off to come out and remains permanently buried. Another and still more interesting case is situated at Mr. Keventer's dairy farm. For many years now useful fodder crops have been grown successfully, with the aid of very liberal applications of manure and water, on land which was formerly some of the worst usar.

To the visitor this land appears to be quite reclaimed. Examination of the soil however showed that although the upper 12 to 18 inches have been rendered fertile, the soil below is as impervious and saline as at first. The cultivation is in fact carried on purely with the help of about a foot of soil. It follows therefore that irrigation must be just as frequent as would be the case were there solid rock below.

In one instance gypsum, which was applied in very liberal quantity 14 years ago, has worked its way throughout the impervious stratum and having not only destroyed the sodium carbonate but also at the same time made the soil pervious to water, this patch has been entirely changed to fertile soil, but at a cost which is quite prohibitive.

At Pusa experiments were made with pot-cultures to ascertain the effects of alkali and imperviousness when acting separately. To this end in one set of tests the alkali was almost neutralised by gypsum without however affecting the impervious character, whilst in another set the soil was rendered permeable to water by the addition of sodium chloride, used in such quantity as not to affect plant growth; the alkali would of course remain. These tests went to show that of the two characteristics of this class of alkali soil, the sodium carbonate is the more severe on plants, though the impervious state was sufficient to practically prevent plant development.

In another set of experiments, also at Pusa, soil is maintained in a very wet state at 20 inches from the surface. The option has been expressed that good arable land becomes alkali under conditions of excessive canal-irrigation which commonly implies a high water-level. For the purposes of the test some soil was dug out of two fields where crops were growing, the adjacent land being usar, the idea being that such land would be more likely to become affected than land remotely situated from alkali patches. It was packed into large stone-ware jars and water has been added to the base so as to maintain the bottom soil in a permanently wet state. At the end of two years an examination of these soils showed that one was free from any sign of becoming usar, whilst the result with the other was doubtful. This experiment is being continued.

**Soils—Regur.**—A very interesting addition has been made to our knowledge of the cause of the black or dark brown colour of *regur* (black-cotton) soil by Messrs. Harrison and Ramaswami Sivan.[2] They confirm the observations of Leather[3] that the black colour is only in part accounted

[2] Memoirs, Dept. Agri. India, Chemical Series, Vol. II, No. 5
[3] Agri. Ledger, No 2, 1898, p. 26.

for by the presence of organic matter, and that it is largely due to mineral matter, and they confirm also the observation of Annett[4] that these soils contain a titaniferous magnetite. At the same time an examination of regur from many parts of the Madras Presidency as well as from the Bombay Deccan and the Central Provinces showed that these soils in Madras often contained only very small proportions of magnetite or none at all, but that all these soils contained another class of dark coloured mineral.

Separations were at first made by the aid of cadmium borotungstate and Thoulet's solution, but with these it was found that the dark coloured substance was liable to disintegration, and acetylene tetrabromide (sp. gr. 2·9) diluted with absolute alcohol, proved to be more suitable. The dark coloured material was found to consist of compound particles. Its amount in these soils is considerable, varying from one-third to one-half of the coarser portion of the soil; the finest portion being excluded.

This dark coloured material has a low specific gravity. Under the microscope it is seen to consist of transparent or semi-transparent grains cemented together by a dark coloured substance. The latter is readily stained by methyl violet and is colloidal. These compound particles are readily disintegrated by pressure. They are comparatively stable in contact with strong reagents; concentrated hydrochloric acid and caustic alkali have little effect on them, though the former dissolves much iron and aluminium. On the other hand, after ignition treatment with hydrochloric acid renders them colourless. Hot concentrated sulphuric acid, however, discharges the black colour entirely, and the residue is now found to consist of white compound particles similar in shape and size to the original. The black material when wetted forms a clayey mass which dries to hard lumps. The fact that concentrated hydrochloric acid, although dissolving large quantities of iron and aluminium from the unignited material, does not remove all the black colour, indicates that this is in part at least due to organic matter. This view is also supported by the following behaviour. Treatment of the unignited material with hydrofluoric acid results in a dark coloured residue, the colour of which is not discharged by either concentrated hydrochloric acid or alkali, but it is destroyed by either hot concentrated sulphuric acid or by ignition. The authors, whilst expressing no very decided opinion, raise the question whether the cementing substance is not an organic compound of iron and aluminium.

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[4] Memoirs, Dept. Agri. India, Chemical Series, Vol. I, No. 9.

Regarding the origin of regur soil the authors consider that, since these soils are found overlying not only trap, as in the Deccan, but gneisses, shales, limestones and kankar beds, and having regard to the fact that the dark colour is largely due to a cementing substance, the materials of which they consist have been derived originally from a variety of rock formations and not exclusively from trap.

**Assam Tea Soils.**—Results are published[5] by Dr. G. D. Hope, of a number of mechanical analyses of tea soils which have been recently carried out in the Calcutta laboratory of the Scientific Department of the Indian Tea Association according to a method which approximates to that of A. D. Hall. The mechanical composition of soils taken from different localities in the North-East Indian tea districts is described.

The soils differ so much that generalisations are difficult to make, but these analyses show that on the whole they contain commonly high proportions of clay.

Some instances are quoted which show how the proportion of fine silt in a soil is correlated to its mechanical properties and the class of cultivation required.

**Indigo.**—Experiments on the chemical selection of indigo (*Indigofera arrecta* Hochst.) has been continued at Sirseah, although under very great difficulties, arising from both floods and pests. Mr. Bergtheil's recent report[6] shows that the Java plant, as at present cultivated, includes two, a high and a low, indigotin yielding plants and possibly two intermediate varieties. Among other indigotin yielding plants which are being studied are *Strobilanthes flaccidifolius*, *Indigofera longiracemosa* and *Wrightia inctoria*. The two first named, both high yielding plants, are probably too delicate to offer much hope of successful cultivation on the large scale, but *Wrightia tinctoria* grows well and may prove of practical importance. In relation to manufacture, experiments have been made in shipping the indigo in the form of paste instead of dried cubes.

**Milk.**—A second Memoir on milk has been published by Messrs. Meggitt and Mann,[7] the subject now being the milk of Indian buffaloes of the Surti, Delhi, Deccani and Jaffarabadi breeds. The conclusions which the authors make may be summarised as follows:—

(*i*) The mixed milk from a herd of these cattle contains from 6·5 to 8·0 per cent. fat in the morning and from 7·5 to 8·5 per cent. in the evening, that is, they find the evening milk to

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[5] Quarterly Journal, Indian Tea Association, Part I, 1912.
[6] Report of the Indigo Research Station, Sirseah, for 1911-12, by Cyril Bergtheil,
[7] Memoirs, Dept. Agri, India, Chemical Series, Vol. II, No. 4.

be the richer by about 1 per cent., a difference which is similar to what was found by these authors for cow's milk at Poona. The milk of the Surti breed was found to be somewhat richer than the others.

(*ii*) During the monsoon period the percentage of fat decreases somewhat, but otherwise the changes due to climate are nominal.

(*iii*) The solids-not-fat in the milk of the Surti breeds varies from 9·5 to 11·5 per cent., the variation for three-fourths of the samples being from 10 to 11 per cent. There is no variation in these constituents between the morning and evening milk.

(*iv*) The ratio of milk sugar : proteids : mineral matter was found to be 6 : 5 : 1; which is the same as was found formerly by Leather.

(*v*) There seems little relationship between the composition of milk of individual animals of the *Surti* breed and the yield, except that the milk becomes *slightly* richer at the extreme end of the period of lactation. Apart from this, the milk yielded by a single buffalo does not seem to vary according to the amount of milk it is giving.

(*vi*) There is very great variation in the composition of the milk of individual animals of one breed, and also between the same buffalo at various times. This last variation in the quality yielded by one animal is much greater than that previously found for Indian cows. The variation in the content of "solids-not-fat" with one animal is practically as wide as for the whole of the animals examined.

(*vii*) The average length of the period of lactation for the *Surti* buffaloes is 53 weeks, but this varies very much, from 32 weeks to 67 weeks.

(*viii*) The yield of milk from a buffalo during the lactation period rises to a maximum almost at once, and remains almost constant for about the first two-fifths of the period. After this there is a regular and steady decline to the end of the period.

(*ix*) There is no relationship between the composition of the milk given by a buffalo and the period of the lactation except when the animal is rapidly becoming dry.

## PART III.—FOREST CHEMISTRY.

BY

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The following is a brief account of the more important work carried out by the Chemical Department of the Forest Research Institute during the year under report:—

**Conifer Resins.**—*Pinus longifolia* resin has been the subject of a detailed investigation both at Dehra Dun and at the Imperial Institute, London, and the results obtained are embodied in the form of a report which is now in press. The turpentine obtained from *Pinus Merkusii* having been already pronounced by Professor Armstrong to be similar to that derived from *Pinus Khasya*, the latter alone has been examined at the Forest Research Institute. *Pinus Gerardiana* occurs at such altitudes that its exploitation for the distillation of turpentine oil would not be commercially possible, hence no effort was made to obtain samples of its resin. The only two species, therefore, left for consideration were *Pinus excelsa* and *Pinus Khasya*. The resins from these two species have been thoroughly examined and samples of turpentine oil have been distilled from them in the laboratory. From the chemical tests of these oils carried out by the Forest Chemist, it is clear that both of them are high grade oils similar in all their properties to the high grade American oil. Samples of both these oils have been sent to the Imperial Institute, London, for commercial valuation. The data for a complete report on the subject are ready but the subject is kept pending till the receipt of the Imperial Institute Report.

**Myrabolams.**—Nine specimens of myrabolams, half ripe, nearly ripe and perfectly ripe, received from the Forest Economist, were examined for their tannin value. It ranged between 44 per cent. to 53 per cent. from October to March in half ripe fruits and between 42 per cent. to 50 per cent. in nearly ripe fruits and between 48 per cent. to 52 per cent. in ripe fruits. From these results the writer in his Note on the best season for collecting myrabolams for tannin material, published in the "Indian Forester" of September 1911, concluded that the longer the fruit is allowed to remain on the tree, the higher is its tannin value, and he recommended that myrabolams should be collected when they are perfectly ripe. In order to support this conclusion, it was proposed to analyse a greater number of specimens from different localities. This

work could not be taken up this year, as no more samples of myrabolams were received. It is hoped that a good number of specimens will be collected for examination from November 1912 to March 1913 and the investigation will be continued next year.

**Tan barks and woods.**—This investigation was started in 1911 and will be continued to the end of the year 1913. The results obtained so far go to show that the percentage of tannin in air-dried barks does not suffer any appreciable decrease, while in the case of barks exposed to atmospheric changes, as is already well known, the tannin is rapidly oxidised.

**Catechin.**—An interesting observation has been made on the total loss of Catechin that the old wood of *Acacia Catechu* undergoes, probably by alternate oxidation and anhydration. In a specimen of *Acacia Catechu* wood 40 years old, it was found that the whole of its Catechin had changed into Catechu red. Another specimen obtained from the Siwaliks, which in its fresh condition in 1907 gave 10·9 per cent. of Catechin, 13·7 per cent. of alcoholic extract and 21·8 per cent. of aqueous extract, gave in 1911 only about 8 per cent. alcoholic extract and 8 per cent. of watery extract and Catechin *nil*. Most of its tannin had also oxidised into Catechu red. This wood was lying in the laboratory exposed to changing climatic conditions for four years, being roughly used for various purposes in the laboratory.

**Canarium bengalense resin.**—The resin of *C. bengalense*, received from the Forest Economist, was refined and then samples were prepared by mixing 8 per cent. and 16 per cent. of bee's-wax to lower its melting point with a view to make the resin serviceable as a shellac substitute in the manufacture of crape, etc. These samples were sent to the Imperial Institute, London, for commercial valuation. The Institute submitted these samples to a firm of crape manufacturers for technical trials with the result that the sample of the resin mixed with 8 per cent. of bee's-wax was pronounced to be most likely to be serviceable, as its clearing properties were superior to those of the refined resin and the one mixed with 16 per cent. of bee's-wax. It was impossible, however, to obtain as stiff a finish with this resin as with shellac. For a soft finish, however, there seemed to be a likely demand. The results of the trial indicated that this resin mixed with 8 per cent. of bee's-wax might find a restricted application in finishing crape. Further work to improve the quality of this resin as a shellac substitute was given up as the tendency of the lac consumers to seek substitutes had ceased, owing to the low price of lac.

**Boswellia serrata gum-resin.**—Attempts were made this year to refine the *Boswellia serrata* gum-resin and to prepare the different products from it. A gum resembling in its properties gum Tragacanth, a resin similar to *Canarium bengalense* resin and an essential oil which has already been reported by Professor Dunstan as consisting of l-pinene and other terpenes were experimentally prepared. It is hoped that the gum mentioned above might probably form a substitute of gum Tragacanth in calico printing, etc., and the resin may find some useful application in the varnish industry and as an adulterant of shellac, but all this has yet to be tested on a commercial scale. The oil seems to be a valuable one inasmuch as it may serve as a base for the preparation of some of the artificial perfumes, perhaps camphor, and it might be useful as a soap perfume. The investigation will be continued next year.

**Podophyllum Emodi resin.**—Three samples of *Podophyllum Emodi* were received from the Forest Economist for analysis with a view to ascertaining the best season for collecting the herb. These samples were collected in May, September and November 1910. From the results obtained, it was seen that the younger the rhizome, the greater is the percentage of resin that it contains. The sample collected in May gave about 14 per cent. of resin, which diminished in September to 8 per cent. and in November to 7 per cent. On the other hand, the percentage of Podophyllotoxin increases with age from 35·34 per cent. in May to 37·07 per cent. in September and to 49·77 per cent. in November. The older root though poorer in resin than the younger root is richer in Podophyllotoxin and consequently more active medicinally. The conclusion arrived at was that the rhizome should be collected in May about the time when the plant is in flower and not in the autumn as has been suggested.

Seventeen samples of Podophyllum roots have been examined at Dehra Dun from time to time during the last four years in order to determine the variation in the percentage of resin contained in the plant. It was found that excepting a sample of rhizome obtained from Kalatop, Chamba, which contained 19·5 of resin, the percentage of resin in the other sixteen samples varied from 8·60 to 16·82 in the rhizome and from 3·9 to 13·94 in the hair-roots. From the results obtained, which have been published in the form of a Forest Bulletin, it would be safe to assert that an average quality of the Indian plant will contain as a rule twice as much of the active principle as the American, and the variation in its physiological properties, as determined in England from time to time an samples sent from India, is accounted for

by the fact that the percentage of the resin in the root as well as the medicinal activity of the Indian plant differs not only with the season of its collection, but also with the locality where grown. In another paper on *Podophyllum Emodi*, contributed by the Forest Chemist to the "Indian Forester," it was suggested that *Podophyllum Emodi* of standard quality could be produced by artificial cultivation and by collecting the rhizome in one particular season.

**Sandalwood oils.**—Ten specimens of Sandalwood have been examined this year for their oil value. A specimen received from the Divisional Forest Officer, Belgaum, Bombay, consisting of wood taken from trees grown on very poor soil covered with sandstone boulders at an elevation of 2,500 feet gave 4·44 per cent. of oil by steam distillation. Four samples of Sandalwood were analysed for the District Forest Officer, North Coimbatore, Madras. Five specimens of Sandalwood were sent by Mr. S. M. Lushington, Conservator of Forests, Central Circle, Madras, taken from the trees grown at the Kodur plantations, East Cuddapah Division, at an elevation of 800 feet only. He suggested that the analysis of these roots should prove of great value as it is usually supposed that at a low elevation the tree does not produce wood of any real value. As the tree has been introduced at low elevations both in the Northern and Central Circles of Madras on a fairly extensive scale, it is important to decide whether there should be any further advance in this direction. The results of the examination of these five specimens show that they contain 4—6 per cent. of oil. These results indicate that the Sandalwood derived from the trees grown at low elevation are quite as rich in oil as the other highly prized ones.

As mentioned in the last year's Report of the Board of Scientific Advice, a preliminary Note on the oil value of Sandalwood from trees grown in rich as well as poor soils, received from Madras, was published last year, but as suggested by the Editor, "Chemist and Druggist," London, a greater number of samples of Sandalwood should be examined to confirm the conclusion arrived at in the said Note. The investigation proposed by Mr. Lushington in the same connection to determine the oil value of Sandalwood grown at low elevation is also an important one. The Forest Chemist, therefore, proposes to include the determination of the oil value of Indian Sandalwood in his next triennial programme in order to investigate more definitely the factors which determine this value by examining at least one hundred specimens taken from trees grown at different localities, different elevations and in different soils.

**Nickel tannates.**—While estimating tannin by means of nickel hydroxide, it was noticed that tannic acid combines chemically with

nickel hydroxide. In order to investigate the chemical composition of the salt formed by the interaction of these two substances, a preliminary investigation was made, which shows that tannic acid combines with nickel hydroxide in different proportions under different conditions of precipitation and formation of the salt. The best method to make these salts consists in precipitating nickel hydroxide dissolved in ammonia and ammonium salts by means of tannic acid solution. In this way a series of salts is formed containing less NiO when the solution of nickel hydroxide in ammonium salts is completely precipitated by an excess of tannic acid solution and more NiO when it is fractionally precipitated.

(1) The solution of nickel hydroxide in ammonium chloride was precipitated fractionally by means of Kahlbaum's "extra pure" tannic acid solution, and the nickel tannate thus formed was first washed by decantation and then in a funnel connected with a filter pump till the washings were free from chlorides. It was then dried in a desiccator in partial vacuum. The desiccator-dry salt was taken both for nickel determination and for the moisture determination at the same time. In this salt, NiO found = 28·5, calculated on the dry salt.

(2) The same as in No. (1), but the nickel hydroxide solution was completely precipitated by an excess of tannic acid solution. NiO found = 8·96 per cent. calculated on the dry salt.

(3) The solution of nickel hydroxide in ammonium acetate was fractionally precipitated by means of tannic acid solution. Further treatment of the salt as in No. (1). NiO found = 23·76 per cent.

(4) The same as in No. (3). The solution was completely precipitated by means of tannic acid solution. NiO = 8·61 per cent.

When freshly precipitated, these salts are amorphous and greyish white in appearance, and on exposure to air gradually oxidise to a darkish brown powder. The salts which are completely precipitated, are more stable than the fractionally precipitated ones and they change their colour but little and that only superficially. They are insoluble in water, alcohol in ether, but dissolve in alkalis, making a dark brown solution out of which they can be precipitated by means of alcohol. The action of caustic soda is somewhat drastic on the salt. Ammonia is the best alkali for the purpose of making salts by precipitation.

In presence of excess of ammonia, the addition of tannic acid does not precipitate nickel tannate from the solution of nickel hydroxide in ammonia. After the addition of tannic acid solution in excess to the ammoniacal solution of nickel hydroxide, the nickel tannate can be

precipitated by the addition of an excess of alcohol. The nickel tannate prepared by precipitation with alcohol from the ammoniacal solution of nickel hydroxide gave 9·95 per cent. of NiO, being the average of two estimations. The composition of this salt very closely agrees with the formula where two molecules of tannic acid enter into reaction with one molecule of nickel hydroxide as shown in the following reaction:—

$$(C_{14}H_{10}O_9)_2 + Ni\ (OH)_2 = (C_{14}H_8O_9)_2\ Ni + 2H_2O.$$

The theoretical percentage of NiO required according to this formula is 10·65. The difference between the value found and the theoretical is 0·7 per cent. But considering that even "Kahlbaum's extra pure" tannic acid cannot be taken to be quite pure, it is clear that the theoretical salt of the above composition is formed by adopting the above process.

This investigation had to be left over for want of time and the Forest Chemist hopes that he will be able to continue it next year.

**Lemon grass oil.**—At the request of Dewan Tek Chand, I.C.S., Deputy Commissioner, Gujranwala, Punjab, a sample of lemon grass oil grown in his garden at Dehra Dun was examined. It contained 74·1 per cent. of moisture and 0·52 per cent. of oil or 2 per cent. on the dry grass.

**Saussurea Lappa oil.**—A sample of the roots of *Saussurea Lappa* (Kuth) of Kashmir was sent to the Forest Chemist by Rai Bahadur Pundit Keshwanand, E.D.C., for the determination of its oil value. The roots gave 13·23 per cent. of moisture or loss at 100° C. and 2·78 per cent. of oil. Messrs. Gildmeister and Hoffman in their "Volatile Oils" give 0·8 to 1 per cent. of oil. This percentage seems to be very low, it may be that the specimens examined were rather old. It would be interesting to analyse more samples of this valuable root. Accordingly Rai Bahadur Keshwanand is trying to obtain more specimens and the Forest Chemist hopes to continue this work next year. This investigation has an economic importance as the oil obtained from these roots is used as an adulterant of the perfume of violets in Europe and it would be worth while to inquire into the methods of its artificial cultivation, the percentage of oil in samples drawn from different localities, and the commercial possibilities of the oil.

**Bamboo paper pulp.**—Mr. William Raitt, F.C.S., Cellulose Expert, attached to the Forest Research Institute, Dehra Dun, has issued an important report on his investigation on bamboo as material for paper-pulp. This is now available in the published form in the

Indian Forest Records, Vol. III, Part III. Mr. Raitt's report gives valuable information on the chemistry of bamboo paper-pulp and he has for the first time removed various erroneous ideas on the subject that had resulted from the conflicting nature of the results of a considerable number of trials and experiments by pulp and paper-makers carried out in a somewhat unsystematic manner.

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# ASTRONOMY.

BY

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**Solar physics.**—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T. Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic

light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disc in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Rowland with $3\frac{1}{4}$-inch ruling is usually employed.

(*d*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during employment of the spectroheliograph and associated instruments.

(*e*) An 8-inch visual achromatic lens from the Maharajah Takhtasinji Observatory, Poona, temporarily mounted in the

spectroheliograph room on a pier near the Foucault siderostat. It is used for forming a solar image on the spectrograph slit specially for sunspot work.

(*f*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a $3\frac{1}{3}$-inch concave grating of 10-foot focus mounted on Rowland's plan. A 2-inch parabolic grating can be substituted for the concave grating, and a collimating lens may be employed with either grating to cure astigmatism.

(*g*) An equatorial refractor, with an Evershed spectroscope attached, used for the spectroscopic study of sunspots and prominences by visual methods.

(*h*) A 6-inch equatorial refractor with a photo-visual object glass (this lens is also from the Maharajah Takhtasinji Observatory, Poona). A large camera has been attached and the whole instrument adapted for taking direct photographs of the sun. It will supersede the Dallmeyer photoheliograph previously employed for this purpose.

**Routine work.**—In addition to the daily records obtained by the two spectroheliographs and the photoheliograph, the routine work includes visual examination of sunspots and faculæ, observations of intensified or weakened lines in sunspot spectra, and of bright lines or displaced lines in spots and prominences. The position angles and forms of the prominences are also recorded. A monthly article describing the solar activity is contributed to the "Monthly Weather Review" while for more technical purposes bulletins and memoirs of the Observatory are issued; of the former 25 have appeared while of the latter the first has been published.

**The solar constant.**—No progress has been made in the method of estimating changes in the solar radiation by photographic comparisons between moonlight and first type stars on account of the difficulty in obtaining suitable apparatus for measuring the plates. It is hoped that satisfactory results may be obtained with a Hartmann photographic photometer which has been recently acquired by the Director.

**Spectroscopic investigations.**—Researches connected with the radial movements of the gases over sunspots discovered here in the year 1909 have been continued, but owing to the very small number of spots available for study during the year very little progress has been possible.

A considerable number of prominence spectrum plates have been obtained and measured for determining the velocities in the line of sight of eastern and western prominences due to the solar rotation. The results so far obtained are of great interest in that they indicate a much higher angular speed of rotation than the value derived from sunspot observations. The hydrogen of the chromosphere is known to be rotating faster than the general body of the sun from the spectrographic researches of Adams, and the prominences arising from the chromosphere and extending outwards into space appear to be forced round at a yet faster angular speed than the chromosphere. Individual prominences show large variations of velocity however and the results referred to are the mean velocities of about 60 prominences. The research will be continued whenever favourable opportunities occur with a view to verifying this preliminary result.

The completion of the electric installation early in the year 1912 has greatly enlarged the general scope of the spectroscopic work and terrestrial comparison spectra of the electric arc or spark can now be photographed side by side with the solar spectrum, the lines of the iron spectrum forming very convenient standards of reference for determining absolute velocities in the sun. As a test of the accuracy of the measurements of motion in the line of sight, as well as of the correctness of the adjustments of the spectrograph, comparison spectra of the sun and the electric arc were obtained with the sun at widely differing hour angles. The first plate was exposed at about 6 P.M. on March 27 and the second at 9 A.M. on March 28. In each plate there is shown a shift of the solar lines towards the red compared with the arc lines. This shift is made up of three components: (1) a shift due to a recession of the earth from the sun amounting at this date to 0·486 km. per second; (2) a shift due to the component of the earth's rotation movement in the direction of the sun, which is a motion of approach in the morning and recession in the afternoon; and (3) a shift of most of the solar lines towards the red and varying from line to line, which is supposed to be due to pressure in the sun's reversing layer.

The shifts due to (1) and (3) are constant for the two photographs, so that the difference of shift shown by the morning and evening plates should give (2). Measures of only 12 lines in the two plates gave a mean result from which is derived the value 0·52 km. per second for the earth's equatorial rotation velocity, or omitting four rather discordant lines 0·46 km. per second. The true value is 0·464 km. per second, a very satisfactory accordance considering the minuteness of the line displacements, which are of the order of 0·01 mm. on these plates.

With regard to the shift of the solar lines supposed to be due to pressure an excellent set of plates of the spectrum of the iron arc in air and the centre of the sun's disc has already been obtained. These will be measured for estimating the amount of the shift in different iron lines. A further set of photographs will be obtained in which the centre of the sun's disc is compared with the arc in vacuo. The measurement of these plates after correcting for the components (1) and (2) will give the values of (3), and these will be compared with known shifts due to pressure and with the relative shifts which the solar lines show when the centre of the disc is compared with the limb.

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## METEOROLOGY.

BY

J. H. FIELD, M.A., B.Sc.

**Experimental work.**—Owing to the absence on medical leave of the Director-General throughout the year and to the great shortness of scientific staff practically no new experimental work was possible during the year. A short series of pilot balloons was sent up in the early morning at Simla during a part of the monsoon, and their results have been worked out for publication with previous ones.

**Publications.**—These were of a routine nature only; no memoirs were published for the reasons which rendered impossible any progress under paragraph 1.

# TERRESTRIAL MAGNETISM.

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

*Director-General of Observatories.*

**Magnetic observatories.**—*Bombay* (*Alibag*).—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city: it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern, a set of sight-reading instruments of Eschenhagen pattern, a Schulze earth-inductor, and ordinary magnetometers and dip-circles. A careful study by means of daily absolute measurements of all elements has shown that while the base line values of the self-registering instruments for declination and horizontal force were constant or varied uniformly within the limits of error, the base line values of the vertical force instrument varied irregularly from day to day, and the mean value of vertical force for a month as derived from weekly measurements, duly corrected from the magnetograph traces, might differ by as much as ·00010 C. G. S. from the mean as derived from daily observations. The examination of the matter is still in hand.

*Dehra Dun, Kodaikánal, Barrackpore and Toungoo.*—These observatories were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained through the year except for three weeks at Dehra Dun in May 1912; the records were then lost owing to dismantling of the instruments in order to permit of the carrying out of the repairs to which reference was made in last year's report.

The mean values of the magnetic elements for 1911 at the observatories are as follows:—

| Observatory. | North Lat. and East Long. | Declination. | Horizontal force. | Vertical force. | Dip. |
|---|---|---|---|---|---|
| Alibag | 18° 38′<br>72° 52′ | 0° 54′ 43″ E. | C. G. S.<br>·36856 | C. G. S.<br>·16250 | 23° 47′·1 |
| Dehra Dun | 30° 19′ 19″<br>78° 3′ 19″ | 2° 29′·2 E. | ·33238 | ·32136 | 44° 2′·0 |
| Barrackpore | 22° 46′ 29″<br>88° 21′ 39″ | 0° 49′·9 E. | ·37337 | ·22220 | 30° 45′·5 |
| Kodaikánal | 10° 13′ 50″<br>77° 27′ 46″ | 1° 0′·2 W. | ·37515 | ·02536 | 3° 52′·0 |
| Toungoo | 18° 55′ 45″<br>97° 27′ 3″ | 0° 19′·3 E. | ·38853 | ·16532 | 23° 3′·0 |

**Magnetic Survey.**—The general scheme was to execute a preliminary survey of the whole country and a detailed survey of those areas where, owing to local irregularities, further information was required. The preliminary survey was to consist of observations of declination, intensity and dip at about 1,100 stations, and measurements were to be made in successive years at about 22 'repeat' stations in order to effect the elimination of secular variation.

Field work was begun in November 1901, and up to the end of the field season 1909-10, 1,324 field stations had been occupied and 23 repeat stations established, in addition to 24 stations on the Seistan trade route where declination had been observed; observations had also been repeated at 142 old field stations, of which 15 have been re-occupied on two occasions. In the detailed survey 193 stations had been occupied.

During the field season 1910-11 three detachments were employed on field work, one under the officer in charge (Captain R. H. Thomas, R.E.), and two under provincial officers; a fourth detachment was employed on office duties at head-quarters.

Two detachments were employed on detail survey in Central India and Hyderabad State, where the Deccan trap area exhibits considerable abnormalities. These detachments also observed at repeat stations and permanently marked field stations in the vicinity of their areas. The officer in charge inspected the four survey base stations, re-adjusting the instruments where required. Comparative observations were made at each base station and at Alibag to determine the differences from the survey standard. Observations were also made at repeat stations and permanently marked old field stations. During the season full sets of magnetic observations were made at 78 detail stations, while 56 old field stations and 18 repeat stations were re-occupied.

The detachment at head-quarters was utilized in initiating the reduction of the declination data of the survey. A simpler empirical formula for the correction for diurnal variation has been devised by Mr. de Graaf Hunter, M.A.: the correction is based on the results of one, two, three or four base stations according to the numbers available at the date of any given field observations.

During the recess the reduction of the base station results for 1911 were completed and those for 1912 taken in hand. The computation of the field work carried out in the field season will shortly be completed.

The investigation of the instrumental differences in H. F., to which reference was made in last year's report, was continued.

The ' chronograph ' comparisons of 1911-12 have but served to confirm the view expressed in last year's report, *viz.*, that the observed discrepancies are to be attributed in the main to personal error in the vibration experiment, and the investigation has therefore practically resolved itself into the determination of the probable personal errors both of the field instruments and the survey base station instruments for the period 1903-09 during which the chronograph was not used.

This investigation will, it is hoped, be shortly completed, when the reduction of the H. F. observations can be put in hand.

*Programme for 1912-13.*—During the next field season, three field detachments will be available. Two will be employed on continuing the detail survey while the third under the officer in charge will visit the base stations and as many repeat stations as possible.

A fourth detachment will continue the reduction of the declination data, remaining at head-quarters.

# BOARD OF SCIENTIFIC ADVICE FOR INDIA, 1911-12.

## GEOLOGY.

BY

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## MINERALOGY AND PETROLOGY.

1. Mr. Tipper continued his examination of the monazite-bearing sands of Travancore, and, in addition, has been able to detect the presence of this mineral in small quantities in very widely separated localities. It has been proved to occur in small quantities in the sands near Tinnevelly and also in the cemented dunes of that district, in the Vizianagram district, in concentrates from the Sabarmati river at Golwara in Idar State, and recently in tin concentrates from Southern Burma. Thanks to the kindness of Mr. H. P. Herbert, Manager, Morgan Crucible Company's Mines in Travancore, and Mr. E. Masillamani, State Geologist, specimens of the monazite-bearing pegmatites of that State have been carefully examined. The monazite is undoubtedly a primary accessory mineral, but, like many other accessory minerals, it

does not follow any particular order in crystallization. Some of these pegmatites are very rich in monazite. In spite of this, the conclusion to be drawn from a study of the sands is that the bulk of the mineral is derived, not from the pegmatites, but from the denudation of the charnockites and granulites in which the monazite probably occurs in small quantities.

2. During the course of his survey of Idar State, Mr. Middlemiss met with a rock of unusual type and one of considerable interest. It occurs as a band at the junction of the Idar biotite granite with the Kawa dyke of olivine-dolerite (gabbro) at one mile north-west of Kawa. Microscopically it is a coarse, dark and light rock, with large poikilitic patches of biotite. It is composed of a fairly large amount of orthoclase, occasionally porphyritic as in the Idar granite, abundant lath-shaped plagioclase (albite-oligoclase) and quartz, a considerable amount of pyroxene in rather small idiomorphic and hypidiomorphic grains, often gathered together into clusters and showing here and there change to uralitic hornblende, a large amount of biotite in great ophitic plates and, as accessories, iron ores and rather much apatite. Mr. Middlemiss regards this rock as a composite or "hybrid" one, due to chemical reactions between the two rocks now found on either side of it, *viz.*, the Idar granite and the younger intrusive Kawa dyke of olivine-dolerite. He concludes that owing to the basifying of the granite consequent on this intrusion, the quartz and orthoclase of the former have remained unaltered, but all the usually dominant microcline has disappeared, its place being taken by abundant plagioclase (albite-oligoclase); at the same time both the biotite and apatite of the granite have been largely reinforced. Or, regarding the reaction from the point of view of the basic rock, the more basic plagioclase (labradorite) has disappeared, as also has the olivine, whilst the pyroxene has persisted in more or less patchy groups. Except on the supposition of a commingling of material and chemical re-arrangement having taken place, it is difficult to classify a rock of such abnormal mineral constitution among the ordinary igneous rocks, and Mr. Middlemiss considers that all the conditions of its occurrence point to its being a hybrid.

3. During a course of study leave spent at Cambridge, Mr. Pascoe made a detailed examination of the lavas from Mount Popa in Upper Burma, and was able to confirm the conclusions of previous observers that these consist exclusively of andesites. He recognises two types, one a hornblende-andesite in which the hornblende phenocrysts show strong absorption borders and much alteration to magnetite, and the other a porphyritic augite-andesite with small rounded grains of olivine.

## PALÆONTOLOGY.

4. **Lamellibranchs and gastropods from the Spiti shales.**—Amongst the collections from the Spiti shales sent to the late Dr. Victor Uhlig for description, there were a number of lamellibranchs and a few gastropods; these were handed over by Dr. Uhlig to Dr. Karl Holdhaus, whose description of the material has now been received and will shortly be published in the *Palæontologia Indica*. Dr. Holdhaus states that his examination of the bivalves tends generally to confirm the conclusions already arrived at by Dr. Uhlig from his study of the ammonites. At the same time the fauna seems to represent a very special and individualised facies, since, with the exception of certain species of *Astarte*, Dr. Holdhaus has been unable amongst 37 species to find a single one that is truly identical with similar species from other regions; he has thus unfortunately been compelled to create a number of new species and one new genus. The gastropods are few in number, poorly preserved and of no particular importance.

5. **Himalayan Ordovician and Silurian fossils.**—A very important work on Himalayan palæontology has just been completed by Mr. Cowper Reed, namely, a description of the Ordovician and Silurian fossils of Spiti and Kumaon. The material described includes Salter's duplicates of Strachey's original collections, Stoliczka's collections from Spiti, Griesbach's from Kumaon, Krafft's and mine from Spiti and Bashahr and various small collections made by Messrs. Hughes, La Touche and others. Mr. Cowper Reed has been able to recognise definitely both Ordovician and Silurian faunas, of which the most remarkable feature is the striking American stamp of the Ordovician. Thirty-four species are closely related to American forms, but "while the affinities of so many species are remarkably close, yet scarcely any or perhaps even none are absolutely identical"; Mr. Reed attributes this to "a certain amount of modification having taken place in the course of their long migration from America." Equally remarkable is the absence from the Ordovician fauna of any European affinities, a fact which is the more striking in view of the very marked European character of the Ordovician of the Northern Shan States. The Silurian fauna on the other hand, although showing distinct American affinities in the corals, is on the whole rather European, although the strong European facies found in the Shan States is not developed.

6. **Triassic fossils from Kashmir.**—Dr. Diener has completed, for publication in the *Palæontologia Indica*, a description of the collections of Triassic fossils made by Mr. Middlemiss in Kashmir during the last few years. Amongst these Dr. Diener recognises representatives of

the Lower Trias, Muschelkalk, and carnic stage of the Upper Trias. The lowest horizon of the Lower Trias, which is found at Pastannah, corresponds fairly closely with the Otoceras zone of Spiti and Kumaon. The genus *Otoceras*, however, has not been found in it, but *Ophiceras* and *Xenodiscus* predominate. An interesting feature of this fauna is the close connection that has been proved between these two last-named genera, the intermediate forms being comprised among Mr. Middlemiss' specimens. The lamellibranchs, however, are more important than the cephalopods, and include large numbers of *Pseudomonots* (*Claraia*), of which four species are particularly interesting as representing isolated elements of Mediterranean origin, but all leading forms of the Werfen beds of the Alps. A younger Lower Triassic fauna containing *Flemingites* and *Meekoceras* is attributed to the Hedenstrœmia stage of Spiti and Kumaon. A fairly rich fauna was obtained from this horizon in the Guryul ravine, and a similar collection from Mandakpal. The marked resemblance between the Lower Trias of Kashmir and that of Spiti and Kumaon is in decided contrast to the absence of resemblance, indeed to the dissimilarity, of the Muschelkalk. Throughout those more easterly parts of the Himalaya, the physical characters of the Muschelkalk are practically invariable, and the steep cliff of the nodular limestone always forms a characteristic feature which cannot be mistaken. This, however, appears to be quite absent from Kashmir. So far as the fauna is concerned, Dr. Diener confirms Mr. Middlemiss' view as to the absence of Lower Muschelkalk forms from all the collections hitherto made, whilst every fossil that can be assigned to the Muschelkalk appears to belong to the Trinodosus zone of other parts of the Himalaya. The only upper Triassic fossils in Mr. Middlemiss' collections consist of lamellibranchs and brachiopods, which, although marked by certain Upper Muschelkalk affinities, are regarded by Dr. Diener as, on the whole, indicative of a carnic age.

7. **Fossil plants from Afghanistan.**—Professor Seward has completed a detailed critical study of the plants collected by Mr. Griesbach and by me in Afghanistan. Mr. Griesbach's collections, which come chiefly from Chahil and Shisha Walang to the north of the Kara Koh (Afghan-Turkistan), are regarded by Professor Seward as perhaps as old as lias or rhætic, whereas my collections, chiefly from the country to the south of the Kara Koh (Saighan and Kahmard), he regards as Middle Jurassic (Inferior Oolite). This rather tends to confirm the suggestion (*Memoirs, Geological Survey of India*, XXXIX, page 77) that the volcanic Doab series of Saighan is represented in Afghan-Turkistan by the estuarine and shallow-water

marine deposits which contain *Halobiæ* of Upper Triassic affinities. Professor Seward also confirms the view that the affinities of the Afghan Jurassic flora are with that of the provinces of Fergana and Syr Darya, that is to say, of Angaraland rather than of Gondwanaland.

8. **Fossil plants from the Assam coal-measures.**—By the kindness of Mr. G. E. Harris, Agent and General Manager of the Assam Railways and Trading Company, Professor Seward has also been enabled to examine certain specimens of the Tertiary flora associated with the coal-seams of Margherita in Upper Assam. Good specimens are rare as the shale rapidly disintegrates on exposure to the atmosphere. In the present instance, however, Mr. Harris had obtained a large fossiliferous block, which he immediately varnished, thus preserving it for some time from the effects of the atmosphere. The fossils consist chiefly of dicotyledonous leaves, which Professor Seward has described under the name *Phyllites kamarupensis*. They are unfortunately not sufficiently distinctive to warrant any statement as to geological age.

## ECONOMIC ENQUIRIES.

### Asbestos.

9. **Idar State.**—During the course of his survey of Idar State Mr. Middlemiss discovered in the hills to the south-east of Dev Mori (23° 39′ : 73° 28′) a deposit of asbestos, which appears to be of excellent quality. It occurs in large rod-like masses, which, when soaked in water and dried, come out as long silky masses of beautifully white fibre. The mineral is the amphibole variety and is long in staple, some fibres being as much as eight inches in length. The deposit is being opened up by the local authorities and, if it proves to be of any size, should be well worth exploiting.

### Coal.

10. **Assam.**—During his investigation of the oil-fields of Assam, Mr. Pascoe took the opportunity of visiting the valley of the Namchik river to the north-east of Margherita. Here he discovered a fine seam of coal, some sixty feet thick. The results of his investigation have already been published in the *Records of the Geological Survey* (Vol. XLI, page 214).

11. **Punjab.**—The proposed borings for coal on the Dilwal plateau of the Salt Range were put down during the latter part of the year, at

Tothral and Arar. These villages lie well back from the southern scarp of the range and are separated from one another by a distance of about $2\frac{1}{2}$ miles. If, therefore, there was a coal-field of any considerable extent below the nummulitic limestone of the plateau, evidence of its presence should be found below Tothral and Arar. No coal, however, was found at Arar, and a seam only a few inches thick at Tothral; at the latter place, the boring was carried to a depth of over 112 feet below the coal into the Olive series, and the general sequence proved to be similar to that at Dandot. The Arar and Tothral sections are given below, and that obtained from the previous boring at Dandot is added for comparison:—

| | Arar. | Tothral. | Dandot. |
|---|---|---|---|
| Surface soil, débris and nummulitic limestone . . . | 99′ 3″ | 117′ 0″ | 127′ 0″ |
| Variegated shales . . . | 10′ 6″ | 10′ 6″ | 11′ 6″ |
| Limestone with some calcareous sandstone . . . . | 131′ 9″ | 156′ 0″ | 140′ 6″ |
| Alum shale . . . . | 27′ 6″ | 24′ 2″ | 30′ 0″ |
| Coal-seam . . . . | ... | 1′ 4″ | 1′ 10″ |
| | Pink marl. | Grey shale. | Dark grey shale. |

The persistence in character and thickness of the variegated shales lying between the two bands of nummulitic limestone is very marked, as also is the uniformity of the lower limestone. The results of these borings lead to the inference that the coal-seam is thinner under the Dilwal plateau than in the neighbourhood of Dandot, that is to say, that it thins out and disappears towards the north. The data are of course insufficient to admit of any definite statement to that effect, but they give us no encouragement to expect that the seam under the Dilwal plateau will ever be appreciably thicker than that along the scarp, whilst the results of these investigations hold out no inducement towards further borings on the other plateaux of the Salt Range.

### Copper.

12. With a view to the preparation of a memoir on the copper deposits of India, Dr. L. L. Fermor was deputed to Sikkim to examine the ore-bodies of that State. The most important are those of Bhotang and Dikchu. Both deposits occur interbedded with the associated rocks,

being of the nature of interbedded replacement deposits; but whereas the Bhotang deposit is in a comparatively unmetamorphosed form of the Daling series, the Dikchu deposit occurs in the belt of highly crystalline mica-schists with associated gneisses, forming a boundary zone between the Daling series and the Sikkim gneiss. In both cases, the copper-ore is chalcopyrite, the chief associated sulphide being pyrrhotite. But, especially at Bhotang, galena and blende are also of somewhat common occurrence. Dr. Fermor finds the origin and mode of occurrence of these ores to be similar to those of the Singhbhum copper-lodes. In each area the lodes are interbedded in the Archæan rocks (Dharwars in Singhbhum and Dalings in Sikkim, the garnetiferous rock of Dikchu being probably a highly metamorphosed form of the Dalings); in each area the bodies of copper-ore have been formed by the metasomatic replacement of the associated rocks; and in each area the copper-bearing formations are close to large masses of granitic rocks, from which, one may conjecture, the copper-bearing solutions were derived. In Singhbhum there are numerous basic (epidioritic) dykes associated with both the granites and the Dharwar rocks (schists, quartzites, etc.), and, as an alternative to the derivation of the copper-bearing solutions from the granites, it is possible to suppose them to be closely connected with the basic dykes. The disposition of the Singhbhum copper deposits as an aureole in the Dharwars following the curvature of the Dharwar-granite boundary is, however, in favour of the former suggestion, which, as it happens, is also more suitable for explaining the derivation of the ores of Sikkim, where basic igneous intrusions are scarce.

13. Although the deposits of Sikkim are similar in mode of origin to those of Singhbhum, they differ from them remarkably in the diversity of their mineral contents which frequently include chalcopyrite, pyrite, pyrrhotite, blende and galena; in Singhbhum, on the other hand, the copper-lodes show, as a rule, only two sulphide minerals, chalcopyrite and pyrite—with traces of chalcocite at higher levels, probably representing a zone of secondary enrichment. In both Sikkim and Singhbhum, azurite, malachite, chrysocolla and chalcanthite are found in the oxidised zones of the lodes, but in Sikkim where the slopes are very steep and denudation under the influence of a moist climate and heavy rainfall is very rapid, the oxidised zones are much less predominant than in Singhbhum. In Sikkim the sulphide minerals may crop out at the surface in the fresh condition, but this practically never happens in Singhbhum, where one might doubt the existence of copper deposits, were it not for the presence of numerous ancient outcrop workings stained with green and blue oxidised copper minerals.

### Engineering Questions

14. **Darjiling landslips.**—During the early part of October, a committee was convened to discuss the safety of the hill-sides surrounding Darjiling. Attention was chiefly centered on the Happy Valley slip, which was examined in detail; various suggestions were made with a view to preventing further landslips, but final measures were postponed pending a detailed geological survey on a large scale of the whole hill-side from the Court-house to the Jail. It is proposed to undertake this in the summer of 1912. Incidentally it should throw much-needed light on the nature and origin of the Darjiling gneiss, which in the Happy Valley appeared to be derived largely from the metamorphism of $a_5$ pre-existing sedimentary series of slate and quartzite.

### Galena.

15. **Simla Hill States.**—A visit was paid to Basantpur in Bhajji State, the site of the head-works of the Simla hydro-electric installation, where galena and stibnite were said to occur. Specimens said to represent deposits of each had been sent previously to the Geological Survey Laboratory, but had proved to be only galena, no ore of antimony occurring among them. The latter was said to have been found on the left bank of the Nauti Khad just above the flume, and two mule-loads of ore were said to have been taken away. In spite of careful search no trace of ore of any kind could be found at this locality; it would appear that the whole deposit had been removed.

A few lumps of galena and a considerable amount of slag are found in the alluvium of the stream running from Basantpur to join the Nauti Khad. The quantity noticed was, however, small and is probably derived from the small veinlets and clusters of galena to be seen here and there in the metamorphic limestone which occurs in large quantity in the neighbourhood. Similar occurrences of galena are common throughout the Simla Hill States and are not as a rule of any economic importance.

### Gold.

16. **Mong Long State.**—On his return from leave, Mr. Coggin Brown was deputed to examine, on behalf of the Sawbwa, the gravels of the Möng Lông Sub-State in Hsipaw, where gold was said to occur in payable amounts. Mr. Brown found that the gravels, although rich in places, occurred in too small quantity to hold out any hopes of successful dredging operations and recommended that the deposits be

left to the Shans to work. A detailed report on the subject has been published.

**Petroleum.**

17. The oil-fields party consisted, in addition to Mr. Cotter, of Mr. K. A. K. Hallowes and Sub-Assistant Sethu Rama Rau. During the early part of the year, Mr. Hallowes was posted to Yenangyaung, but, after the monsoon, resumed field-work in the Pakokku district, where he has been engaged on a survey of the volcanic area in the northern part of the district. Sub-Assistant Sethu Rama Rau was engaged in mapping the area included in sheets 113 and 157 (Burma Survey, 1″ = 1 mile) covering parts of the districts of Minbu, Thayetmyo and Magwe. Three anticlines were noted in this area, *viz.*, (1) the Migyaunge-Kyundaw anticline, (2) the Tagaing-Sinmadaung and (3) the Mindegyi-Kyawdo. Of these the first is approximately symmetrical, and has shallow dips ranging from 10° to 25°, the Pegu beds being continuous with those of the Minbu oil-field. The conditions are regarded as favourable for the storage of oil. The Tagaing-Sinmadaung anticline is asymmetric on the north and symmetrical on the south, but the dips are very high, and the economic possibilities of the area are regarded as poor. The Mindegyi-Kyawdo anticline is a symmetrical one with shallow dips ranging from 10° to 25°. The Pegu beds here are the continuation of those exposed near Yenaman and Thabyemyaung, where seepages are numerous; the area is therefore regarded as decidedly promising.

**Steatite.**

18. **Idar State.**—Reference has already been made to the asbestos found by Mr. Middlemiss in Idar State. It occurs among, and is closely associated with, large quantities of steatite. The latter is found between Dev Mori and Kundol (23° 40′ : 73° 28′) and also at Ghánta (23° 36′ : 73° 26′). The steatite is of very fair quality and occurs in enormous quantity, Mr. Middlemiss having calculated that at the first locality alone there are over two million tons in sight and within easy reach. A note on the subject has been published in the *Records of the Geological Survey*, Vol. XLII, page 52.

**Tin.**

19. **Nurunga, Hazaribagh district.**—In July, Dr. Fermor visited the Nurunga tin locality, already noticed in *Records of the Geological Survey of India*, Vol. XXXIII, page 235 (1906). The deposit was found to be of a very unusual character, consisting of a thin

band, some 6 inches thick at most, of cassiterite-granulite, forming an interbedded layer in a considerable thickness of microcline granulite: in addition to the band mentioned above—which often contains a very high proportion of cassiterite, as much as 30 to 50 per cent.—cassiterite is also found in sparsely scattered granules in the microcline-granulites, especially close to the cassiterite-granulites. Samples of the country-rock have not yet been analysed, but it seems unlikely that the amount of included cassiterite is sufficient to render the whole mass of rock worth treating as an enormous deposit of low-grade tin-ore. The specimens collected have not yet been thoroughly studied, but the mode of occurrence of the tin suggests that the cassiterite-granulite is a basic segregation from the acid granulites with which it is associated.

See also under *Wolfram*.

### Water.

20. At the request of the Local Government, it was arranged that a traverse should be made across the Irrawadi valley from the western foot of the hills of the Southern Shan States to the outer ranges of the Arakan Yoma, with a view to ascertaining the possibility of obtaining supplies of water under artesian conditions. The work was undertaken by Mr. P. N. Datta, who made a complete traverse along the latitude of Pyawbwe. On the whole, the result was not very encouraging, but Mr. Datta indicated various spots at which artesian water might be found.

### Wolfram.

21. **Burma.**—At the request of the Local Government, Mr. Page was again posted to Tavoy and Mergui with a view to assisting the local officials with advice in matters relating to tin and wolfram-mining. Owing to the great rush for wolfram concessions in Tavoy and to the complete absence of reliable maps, he found that there was great difficulty and delay in connection with the issue of prospecting licenses. Matters, however, are being gradually reduced to order and it is hoped that before long all pending applications will have been dealt with.

## GEOLOGICAL SURVEYS.

### Assam.

22. **Naga Hills: Mr. E. H. Pascoe.**—Having been deputed to Assam for the field-season 1910-11, Mr. Pascoe was permitted to accompany a column that left Kohima early in January for a visit to Makwari on the Assam-Burma border. The greater part of the traverse,

which was some 85 miles in length, lay over a monotonous sequence of Disang shales and slates with little to relieve it save occasional lenticles of quartz. Among the Disang beds, between Dimapur and Kohima, was recognised the Naogaon sandstone of Mallet forming the peaks of Kadiuba and Siwenuchika. In the extreme east of the area, occurrences of serpentine were observed corresponding to the band mapped by Mr. R. D. Oldham in Manipur. A thick massive conglomerate was another interesting feature of this part of the traverse. The serpentine has been derived from gabbro and peridotite, pieces of which rocks are common in the streams.

23. **Abor Hills.**—The despatch of an expedition to the Abor country offered an opportunity for exploration of a tract of which the geological conditions were entirely unknown and it was therefore decided that a member of the Geological Survey should be attached to the force. Mr. Coggin Brown was selected for the purpose and joined at Kobo early in December. Mr. Brown has been able to add largely to our knowledge of this part of the Himalaya and he deserves great credit for the energy and perseverance with which he pursued his work in the face of the many difficulties inseparable from an expedition of the kind. It was anticipated that the general sequence of strata recognised at different times in the outer zone of the Eastern Himalaya would be more or less followed in the Abor hills, and this proved to be the case. From Kobo northwards the flat alluvium was found to stretch to the foot of the hills as far as Pasighat. In every direction it is covered with dense forest and the luxuriance of the vegetation entirely masks the ground. North of Pasighat the road soon commences to rise over pleistocene deposits lying on a core of Siwalik rocks, and at Janakmúkh there is a raised terrace section of pleistocene gravels 150 feet in thickness, the top of which is 350 feet above the present level of the Dihong.

24. The Siwaliks were crossed on the line of march between Pasighat and Rammidumbang, forming the outer lower-lying foot-hills which flank the higher ground to the north; they were found to consist of great thicknesses of various kinds of sandstones, the softer micaceous varieties often containing nests of bright lignite, undoubtedly the remains of waterlogged drift-wood deposited during the formation of the rocks. Landslips are very common in this zone and from the high Abor "jhums" (clearings) the light-coloured Tertiary strata show up well against the dark green of the Sub-Himalayan rainy forest which covers the hills.

25. The Siwaliks dip into the hills and have the customary appearance of being overlain by the Himalayan Gondwanas, the next series met with. Unfortunately no actual contact of the two systems was seen, but there is no doubt that it is the same here as elsewhere. The commonest rock types in this series are white and greyish-white indurated sandstones and quartzites, reddish ferruginous shales, black carbonaceous shales, often with clay-ironstone septarian nodules, hardened, greyish-blue shales in which a schistose structure has been developed, and coal-seams. Owing to the intense crushing to which they have been subjected the seams have been squeezed into lenticular patches and the coal itself rendered powdery and friable. It is believed that these coals are of no economic value. Near Renging bands of decomposed volcanic rock begin to make their appearance, interbedded with the Gondwanas, and further north there is a great development of trap-like rocks which have given rise to the peculiar physical character of the narrow gorge-like course of the Dihong through the lower Abor hills. These rocks have been named the Abor Volcanic series, but at present, mainly owing to the want of continuous exposures, it is not possible to fix their exact age, though in the presence of palagonite tuffs they bear a striking resemblance to the Rajmahal traps. This series is followed higher up the valley by metamorphic rocks which in general appearance and position appear to correspond partly with the Daling series of Sikkim.

### Bombay, Central India and Rajputana.

26. Messrs. Middlemiss, Jones, Heron and Daru were engaged in the survey of parts of Bombay, Central India and Rajputana, together with a few connected areas in the Punjab and United Provinces which border the part of Rajputana worked by Mr. Heron.

27. **Mr. Middlemiss: Idar State.**—Mr. Middlemiss began work in Idar State, and spent from January to April there investigating a portion of the country new to the Geological Survey, but lying immediately south of Hacket's and La Touche's surveyed areas in Rajputana and north of Kishen Singh's mapped areas in parts of Bombay. He completed a well-defined area of about 729 square miles, lying centrally within sheets 118 to 120 and 144 to 146 of the Bombay 1″=1 mile survey. The banded and bedded formations represented are a folded (N.N.E.—S.S.W.) complex of Aravalli calc-gneisses and other schists, Delhi quartzites—coming apparently above and folded with the latter,—Ahmednagar sandstone series and recent deposits. The most common form of the first of these,

occurring in limited exposures among vast spreads of alluvium, is a thoroughly crystalline aggregate of much calcite with varying amounts of quartz, microcline, plagioclase, diopside and sphene, and occasionally with much biotite or with wollastonite, scapolite, garnet and zoisite. Among it ramify innumerable small granitic veins of aplite, graphic granite, and pegmatite, which seem to be as old as the folding of the rocks among which they appear. There are also later intruded, rugged and grotesque, large masses of Idar granite (biotite and hornblende granite) and of quartz-porphyry bursting irregularly through the region regardless of the older series. Long sinuous dykes of vein-quartz (ultra-acid differentiation products of the Idar granite?) and one or two examples of a basic dyke (olivine-gabbro or dolerite), together with a contact, composite or hybrid rock, between the latter and the Idar granite, were also identified and mapped.

Of these intrusive rocks, Mr. Middlemiss specifically identifies the Idar granite with the Siwana and Jalor granites, and the quartz-porphyry with the Malani rhyolites of Western Rajputana (see La Touche, *Mem. Geol. Survey of India*, Vol. XXXV, pt. 1, pages 25 and 90—91) and the olivine-gabbro and dolerite with a very similar one also in Western Rajputana, described by Sir T. Holland (*loc. cit.*, page 91). But there are further resemblances between the two areas in the nearly horizontal Ahmednagar Sandstone series, which appears as cappings on the hills or in the deeply-cut rivers under the alluvium, and which probably represents the Barmer sandstone of Western Rajputana as well as the Lathi group of Jaisalmir and the Umia of Kathiawar.

28. **Economic.**—No minerals of sufficient importance to notice here have as yet been found, but the sandstone quarries at Ahmednagar yield an excellant free-stone, whilst marble and granite can also be obtained in any quantity.

29. **Mr. Jones: Gwalior.**—Mr. Jones spent a full season, from November to the middle of May, in the Amjhera and Ujjain districts, continuing the revision of the geological maps of the area and the investigation of the mineral resources of the State. The area is contained on sheets nos. 212 to 215 and 242 to 247 of the Central India and Rajputana survey (1″ = 1 mile). Of this the Bag area to the south took him to the interesting localities already surveyed generally by Messrs. Blanford and Wynne (*Mem., Geol. Survey of India*, Vol. VI, pt. 3) and later again in more detail by Mr. Bose (*Mem., Geol. Survey of India*, Vol. XXI, pt. 1).

30. Although Mr. Jones was primarily concerned with the possibility of finding ores of manganese in the crystalline rocks, he has incidentally contributed a newly coloured map of most of the Bag area in even greater detail as regards delineation of boundaries than the already detailed work of his immediate predecessor Mr. Bose. A feature of special interest in his report of this area, where the sequence of beds comprising Nimar sandstone, Nodular limestone, Coralline limestone, Lameta and Deccan Trap lie almost horizontally above the steeply dipping Bijawars or still older gneissic and metamorphic series, is the beautiful set of photographs which he has taken in illustration of this and other physical features. His report may generally be considered as a further study in a number of detailed and well-illustrated sections taken at points of special interest of the area already liberally treated by Bose. A further addition to the fossils, of about cenomanian age, collected especially from the Nodular limestone and the Deola and Chirakhan marl has also been made by Mr. Jones. Among these Mr. Tipper has specifically recognised *Hemiaster similis*, *Placenticeras mintoi* Vredenburg, and *Namadoceras scindiæ* Vredenburg. As before, no fossils were obtained from what have been called Lameta beds at the base of the Deccan trap, so that the points in debate with regard to that formation remain as they were.

31. **Economic.**—No manganese nor anything of special economic importance was found. In the Bijawar rocks near Bag, however, Mr. Jones found promising slates, and he has suggested that pits be opened in them to determine their quality and suitability for roofing, writing slates, etc.

32. **Mr. Heron: Rajputana, Punjab and United Provinces.**—From the middle of November to the first week in May Mr. Heron spent a full season in continuation northwards, eastwards and south-eastwards of his work in Alwar of the last two seasons. The formations exposed constitute isolated hill groups, gradually dying out in the Indo-Gangetic alluvium to the west of the Jumna, during which process they spread out from Rajputana (whence the work of determination originated) into the neighbouring areas of Delhi and Gurgaon districts of the Punjab, and Agra and Muttra districts of the United Provinces of Agra and Oudh. This large area is included in Atlas of India sheets 49 and 50 (1″=4 miles), and standard sheets (1″=1 mile), Punjab Survey nos. 321 to 325, Central India and Rajputana Survey nos. 283, 284, 312, 313, 337 to 341, 360 to 362, and United Provinces Survey no. 23, all of which are now completely surveyed.

33. The rock systems include those of the Alwar State already described in previous reports by Mr. Heron, namely, Aravallis (schist

series of Hacket), above these the Alwar quartzite series, which in the Biana hills becomes split up into several groups, and above these the Ajabgarh (Mandan) series of slates, shales, etc. Besides these, in the area surveyed there are examples of Hacket's "Gwaliors" of Hindaun (thinly laminated cherts with jasper layers) and the Bhander and Rewa sandstone stages of the Upper Vindhyans, which are not found in Alwar.

34. Notwithstanding the large surface covered, practically only one sheet (Central India and Rajputana no. 341) presents any variety of geological feature. This is embodied in the hilly mass of Alwar quartzites north-west of Biana and the Upper Bhander scarp to the south. The rest of the sheets comprehend long tailing-out ridges or hill-masses of either the Alwar series and Ajabgarhs with a few pegmatite veins, or of the Rewa and Bhander stages in monotonous regularity, the greater part of the structure of the country and all geological boundaries being hopelessly buried under the all-pervading alluvium.

35. With reference to the Biana hills in sheet 341, it is to be noticed that Mr. Heron upholds Hacket's sub-divisions of the Alwar series into five groups (*Rec., Geol. Surv. India*, X, 87, and XIV, 298), with one unconformity and several conglomerates indicating breaks in the succession. Near the middle of the lowest group (the Nitahars) there are two bands of volcanic rocks, traps and tuffs, the former of which Mr. Heron has determined as a dolerite in which the plagioclase has been replaced by quartz and muscovite or kaolin, and the augite by chlorite.

The "Gwalior" cherts of Hacket, Mr. Heron thinks may belong to the schist series and not to the true Gwaliors.

36. **Economic.**—Impure graphite and a tradition of gold at Sohna, some old copper workings west of Nitahar and the kaolin of Kasampur have long been known and are mentioned in the *Manual of the Geology of India*, Vol. III. Nothing further of importance has been found by Mr. Heron in connection with them. He describes, however, an excellent band of slate at present being worked by the Kangra Valley Slate Company near Kund railway station. Building stone from the long-celebrated Upper Bhander sandstone quarries in Bharatpur State is of excellent quality.

37. **Mr. Daru: Banswara and Dungarpur.**—Mr. Daru spent only a very short field-season engaged in the above survey, namely, the months of March and April. During the first fortnight of this he was occupied in Banswara, the completion of the survey of which left him free to pass northwards and westwards into new ground

in Dungarpur, where he surveyed 250 square miles in the extreme north-east of that State (sheets 175 and 176 of the Central India and Rajputana Survey). Mr. Daru describes the area as being entirely of Aravalli rocks, with igneous intrusives and a few patches of recent alluvium, most of the country being a continuation north-west along the strike of the formations as found in Banswara.

38. The Aravallis are of the "argillaceous" type, generally biotite schist, occasionally with garnet and staurolite, sometimes too with a large proportion of magnetite. This passes locally into quartz-schist. There is also found hard shale, phyllite, graphitic shale, muscovite schist, hornblende schist and apatite schist. Boulder beds preponderate in one area east of the Sabla chain of hills. Limestone is comparatively rare, such outcrops as occur being extensions from the Banswara area. Two bands of ferruginous cherty quartzite are found, also in extension of the Loaira rock from Banswara.

39. The intrusives in these consist of aplite, graphic granite and muscovite pegmatite, occasionally with tourmaline; and there are also quartz-felspar rock and vein-quartz, the latter being in both large and small veins and regarded as extremely acid representatives of the pegmatites. Granite, gneissose granite, syenite and diorite are also found. In two or three bands there are also examples of "interbanded quartz-hornblende schistose intrusives."

## Burma.

40. The work of the Burma party has already been referred to under *Petroleum* and *Water*. In addition to the systematic survey being carried out in the oil belt, a survey was begun by Mr. Datta of the country lying along the western foot of the Shan Hills from Kyaukse southwards. Work was begun only just before the end of the year and there is therefore but little to report. Mr. Datta finds that the country in the neighbourhood of Kyaukse consists of an altered sedimentary series, now consisting of argillite, quartzite, micaceous schist and marble, associated with biotite granite to which the metamorphism of the sedimentary rocks is probably to be attributed.

## Central Provinces.

41. It was decided this year to form a new field party, in addition to those already at work in Burma and Central India, the new party being for the systematic survey of the Central Provinces on the scale of 1″ = 1 mile. Previous work in this province has been carried out on a variety of scales, and much of the province is practically unsurveyed.

The party has been placed under the charge of Dr. Fermor, and, as constituted for the field-season of 1911-12 includes also Messrs. H. Walker and C. S. Fox, Assistant Superintendents, and M. R. Ry. Vinayak Rao, Sub-Assistant. Babu Bankim Bihari Gupta, recently promoted from the post of Museum Assistant to one of the newly sanctioned posts of Field Collector, was also sent with this party in order to collect a typical series of Chhindwara rocks. The first area selected for survey comprises, on the northern line, the districts of Betul and Chhindwara as far north as the Satpura coalfields and the districts of Seoni and Mandla as far north as the district boundaries, and, on the southern line, the districts of Nagpur, Bhandara and Balaghat as far south as the Bengal-Nagpur Railway line. This area has the advantage of being, as far as is known, a homogeneous geological entity including a large proportion of unmapped country and the whole of the Central Provinces manganese-ore deposits with the exception of those of Jubbulpore. Maps on the 1″ scale are available for the whole of this area with the exception of the Nagpur district, of which the largest maps available are on the scale of 1″=2 miles. The Surveyor-General has, however, kindly modified the programme of work of the Survey of India party now engaged in preparing new maps of the Central Provinces and Berar so as to issue the topographical sheets of this district within the next two or three years. Meanwhile, work was commenced during the current field-season (1911-12) on the northern line of districts. The Betul district has been assigned to Mr. Walker, whilst the remainder of the party accompanied Dr. Fermor to the Chhindwara district in order to become familiar with the rock formations, the study of which was commenced as long ago as 1903 (Fermor, *Records*, XXXIII, pages 159—218, 1906). Sub-Assistant Vinayak Rao has since been sent to Seoni to commence mapping in that district on the lines established at Chhindwara, whilst Messrs. Fermor and Fox propose to survey the Chhindwara district jointly, as it contains a large area of varied Archæan rocks and gives a section across the Satpura Hills from the 1,000-ft. Nagpur-Balaghat plain on the south, across the Chhindwara plateau (2,200-ft.) in the middle, to the Mahadeo Hills bounding the southern edge of the Narbada valley on the north and frequently rising to elevations of over 3,000 feet. It is expected that a detailed survey of this district will furnish the key to the structure both of the Satpura Hills, which traverse the northern line of districts, and of the Archæan plains comprising the larger portion of the southern districts.

42. **Deccan Trap.**—In the short portion of the current field-season falling within the year under review, the only work carried sufficiently

far for report here is the detailed mapping of some 70 square miles of Deccan Trap lying on the 2,200-ft. plateau round the villages of Linga and Lahgarua, to the south of Chhindwara town. Dr. Fermor began detailed work on this area with the object of determining, in the first place, whether it would be possible to break up the Deccan Trap formation into divisions sufficiently well-marked to be easily mapped, or whether it would be necessary, as seemed probable, to colour the whole of this formation with one tint. Incidentally he wished to study in some detail the inner relationship of the vast succession of lava-flows, especially as to origin. Mr. Harker has expressed the view in his *Tertiary Igneous Rocks of Skye*, that the columnar doleritic flows interbedded in the Tertiary basic lavas of that island are sills intruded between the flows of extrusive basalts. To ascertain whether or not any such explanation could be applied to the Deccan Trap, it was decided to map, flow by flow, a selected area in which the existence of dolerite had been ascertained. Dr. Fermor and Mr. Fox first mapped a portion of the area jointly, determining the existence of four distinct flows; they then separated, Mr. Fox carrying the boundaries to the northern and western edges of the selected area and Dr. Fermor to the southern and eastern. The results of their work are of considerable interest. Each flow—except the uppermost, the surface of which has been denuded away—shows a vesicular, more or less amygdular, surface; and between each pair of flows there is usually an 'intertrappean' layer. This sometimes takes the form of a silicified sedimentary stratum a few feet thick—in some cases of limestone, and still frequently containing abundant silicified fossils, *Physa*, *Paludina* and *Lymnæa* (?)—whilst in others the intertrappean layer consists of a green clay, the 'green earth' of Indian geologists, sometimes associated with brownish and cream-coloured clays. The origin of this green earth seems to vary; in some cases, it has undoubtedly been formed by the alteration of the underlying lava surface, but in other cases the origin is doubtful. Sometimes both green earths and sedimentary intertrappeans occur together, the green earth usually overlying the sedimentary rocks. Mr. Fox has collected for careful study a series of specimens of green earths and green jaspers, both from these intertrappean layers and from the lava flows themselves.

43. The flows are numbered serially 1 to 4 from below upwards, flow 1 being the true basal flow in this area, as it rests directly upon the Chhindwara granite. With the exception of flow 2, all have normally the texture of basalts, but any flow may be exceptionally more coarse-grained, *i.e.*, doleritic. Flow 2 is, however, usually a crystalline dolerite,

and if any flow were to prove intrusive, it would be this one. Several other doleritic flows were discovered later in the season on the edge of the ghats fringing the Kanhan valley, but nowhere was any evidence of intrusive relations detected. On page 259 of the *Manual of the Geology of India*, second edition, the existence of phenocrysts of olivine in the Deccan Trap is referred to, but it is probable that the phenocrysts of plagioclase, so abundant in the basalts, have been mistaken macroscopically for olivine, for none of the officers working on the Deccan Trap formation of recent years have been able to detect this mineral in thin sections under the microscope, although serpentinous patches are commonly seen, representing in some cases, perhaps, original olivine. It is interesting to record, therefore, that both Dr. Fermor and Mr. Fox independently discovered olivine in flow 2, in which it appears to be a normal constituent, although frequently altered completely to serpentine, and rarely quite fresh. The separate flows do not rest on each other with horizontal surfaces, and by the judicious use of the aneroid, frequent surprisingly high variations of a particular flow from one point to another have been detected. Marked dips of several degrees have been noticed in many places. As it was uncertain whether any or all of these dips were to be regarded as due to tectonic disturbances or were to be attributed to the flows adjusting themselves to the irregularities in the surface of the underlying Archæan peneplain, Mr. Fox returned to the area at the end of the field-season when nearly all the streams were dry and the crops cut, so that the outcrops could be easily followed; as the result of this he has obtained evidence supporting the former supposition, and has succeeded in tracing out the position of gentle synclines and anticlines striking north by west and south by east. The probable truth of the explanation of these dips as due to post-Deccan Trap tectonic disturbances is supported by several marked dips observed by Dr. Fermor on descending the edge of the Deccan Trap plateau by the Ramakona ghat. It is not unlikely, however, that when the observations obtained are carefully worked out, some of the irregularities will prove to be due to the adjustment of the flows to the underlying Archæan peneplain.

44. The result of this work has been to show the possibility of mapping the Deccan Trap in detail, although it has proved exceedingly difficult and slow work; but, unfortunately, it will not be possible to continue this detailed work owing to limitations of time, although it is evident from the discovery of the gentle folds in the Deccan Trap referred to above that further detailed work might yield valuable results from the tectonic point of view. Further, this work indicates that there is no practicable grouping of the flows in this area suitable for mapping,

45. **The Shikarpur "craterlets."**—Whilst carrying out the detailed survey of the Deccan Trap lavas referred to above, Dr. Fermor discovered a series of remarkable, more or less circular, depressions in the surface of flow 1 in the Kulbehra river opposite to the village of Shikarpur. There are in all some 20 of these depressions varying from 3 to 23 feet in internal diameter. Some of them are beautifully circular, and, where filled with water, look as if they had been drawn with a pair of compasses, whilst others are oval or somewhat irregular in shape. Almost invariably these depressions have a raised rim (1 to 3 feet high) separating them from the surrounding lava surface. Whilst the material composing these rims is a compact, comparatively non-vesicular lava, that composing the main surface of the flow is vesicular and amygdular, as also is the lava occupying the interior of these depressions, where seen. The exact nature of these depressions is difficult to understand, but Dr. Fermor is inclined to regard them as vents formed on the surface of flow 1 as outlets from that flow only, probably for steam and gases, and perhaps also in some cases to release lava from still molten pools within the body of the partially solidified flow. There is some evidence of lava piled up by the side of one of these depressions. It is proposed, therefore, to call them 'craterlets,' in the absence of any better name. Nothing in the least like them is known anywhere in the Deccan Trap formation, except the gigantic Lonar Lake crater in Berar, which must have been formed after the close of the Deccan Trap extravasations; whilst these Shikarpur craterlets must have been formed before the erruption of flow 2 in the Chhindwara district and have been exposed by subsequent denudation.

## Punjab.

46. The survey of the Tertiary rocks of the outer Himalaya in Kangra and the Simla Hill States was continued by Dr. G. E. Pilgrim, who was accompanied by Sub-Assistant Vinayak Rao. Dr. Pilgrim's general conclusions were referred to in last year's report and need not be recapitulated here. A considerable area was mapped on a scale of $1'' = 1$ mile.

## Sikkim.

47. During his visit to Sikkim, Dr. Fermor took the opportunity of travelling as far north as Lamteng in the Lachen valley, in order to obtain an idea of the nature of the crystalline rocks lying between that place and Gangtok, and especially to examine the crystalline limestones (*Mem., Geol. Survey of India*, XXXVI, page 18) for purposes of

comparison with those of the Chhindwara district, Central Provinces (*Records*, XXXIII, pages 195—206, 1906). Until larger-scale topographical maps of Sikkim are prepared, it will not be desirable to map the geology in greater detail than is shown on Mr. P. N. Bose's map in *Records, Geol. Survey of India*, XXIV, which may be accepted as roughly correct. This map shows a large shield-shaped area of Dalings with the point of the shield to the north; the eastern edge of the shield has a north-north-west trend, corresponding with a similar strike of the Dalings and a general east-north-east dip under the crystalline complex which extends from this boundary right up to the Teesta, Lachen and Lachung valleys. This crystalline complex comprises both igneous and sedimentary rocks, the former consisting chiefly of varieties of biotite-gneiss, and the latter principally of limestones, calciphyres, mica-quartz-schists and quartzites. A large-scale map would show these para-schists as long strips striking north-north-west parallel to the strike of the ortho-gneisses, and Dr. Fermor advances the tentative view that these strips, which are presumed to be of sedimentary origin, represent portions of the Daling series folded in with the ortho-gneisses and rendered at the same time thoroughly crystalline. The Dalings may well be the equivalents of the Dharwars of the Peninsula (*Mem., Geol. Survey of India*, XXXVI, page 66), and in this case we may regard the associated gneisses as the foliated forms of post-Dharwar granites intrusive with regard to the Dalings. In support of this view of the nature of these para-schists, it is interesting to notice that the slates of the Daling series become more crystalline—phyllitic—as the gneiss boundary is approached.

# GEODESY.

BY

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## PRINCIPAL TRIANGULATION.

Since the submission of the last report to the Board of Scientific Advice, principal triangulation has been carried on in Bengal and Kashmir.

### Bengal.

*Chota Nagpur Division. The Sambalpur Series.*

For the purpose of establishing well-fixed points to serve as base stations for secondary triangulation in the tracts between the meridians of 82° and 86°, south of latitude 24°, a principal meridional series has been commenced, emanating from the side Bhursu-Hariharpur of the Calcutta Longitudinal Series at a mean longitude of 85°, and extending southwards with a view to junction with the East Coast Series in about longitude 84°.

The tentative scheme of triangulation framed before the observers took the field included the extension of the new series from the side Birpokar-Turer of the Calcutta Longitudinal Series, in longitude 84° 7′.

Examination of the country over which the triangulation would have to be carried, however, showed that it was impossible to lay out well-proportioned figures with unobstructed rays. Reconnaissances were made, both to the east and west, but until longitude 85° had been reached the same unfavourable conditions were found to exist. Plateau succeeded plateau, each thickly wooded, on which mutually intervisible stations at suitable distances apart were difficult to locate and where, without the construction of tower stations, grazing rays could not be avoided. The topographical conditions place this region among the most difficult, from the triangulator's point of view, that India has to offer.

The deflection by 1° of longitude of the new series from its ruling meridian of 84° was held to be less objectionable than the adoption of an expensive scheme of tower stations and accordingly the new series

broke off from the Calcutta Longitudinal Series in longitude 85° and, as soon as possible, was bent towards the west to regain the 84th meridian.

By the middle of April 1912, the series had reached latitude 22° and consisted of four quadrilaterals and one pentagon with a central station, the two southernmost figures lying astride the meridian of 84°. This triangulation, 112 miles in length, covers an area of 2,570 square miles.

The mean triangular error of 21 triangles is 0″·473, the observations being taken with a 12″ two-microscope theodolite.

An astronomical azimuth was observed at Bhursu H. S. of the Calcutta Longitudinal Series, latitude 23° 16′, longitude 84° 44′. The value of the difference (Astronomical – Geodetic Azimuth) being – 6″·07.

## Kashmir.

### *The Kashmir Principal Series.*

At the time of submission of last year's report this series had been carried as far as Gilgit, and Lieutenant Bell, R.E., and Mr. Wainright had commenced reconnaissances to the northwards, the former of the Sakiz Jarab Range and the latter of the Hunza Valley, with a view to framing a scheme of triangulation connecting the Kashmir Principal Series with Russian triangulation on the Pamirs.

As regards the feasibility of establishing stations on the Sakiz Jarab Range, Lieutenant Bell reported that the main chain of peaks was inaccessible and that the hills immediately to the south, only a little less difficult to negotiate, were useless for his purposes as the view from them to the south was obstructed by high inaccessible peaks. He then explored and found impracticable the valley from Darkot to Garmush, 20,564 feet, and later ascended a peak to the south of the Darkot-Askuman Pass. From this point he obtained a view of the summits of the Sakiz Jarab Range. He reports, "the whole range consists of nothing but extremely sharp and precipitous peaks, while south of it, between the Yasin and Karambar valleys, there are many high peaks." This country, just to the east of the Darkot Pass, was thus found to be impossible of triangulation, and an examination was made of the Karambar valley. It was found that triangulation could probably be carried as far as Harmot or Imit, but that northwards from this place the valley becomes very narrow between precipitous hills and the further progress

of a triangulating party was impossible. The normal difficulties were increased by the flooded condition of the river and further reconnaissance in this district was abandoned for the time being with a view to its resumption when the river subsided. In the meantime, however, a feasible route had been found up the Hunza Valley and the whole efforts of the detachment have since been devoted to carrying triangulation northwards along that line. The connection of the Russian triangulation by principal work in this locality has therefore been abandoned.

## SECONDARY TRIANGULATION.

### Bengal.

*Chota Nagpur Division. The Ranchi Secondary Series.*

One hundred miles of secondary triangulation were completed in the neighbourhood of Ranchi. The series emanates from the South Parasnath Series at about latitude 23°, on the meridian of 85°, and following this parallel closes on the new Sambalpur Principal Series in longitude 84°. The triangulation covers an area of 988 square miles and numbers 13 triangles with an average triangular error of 2″·17. An 8″ micrometer theodolite was used.

### Central India.

*Hyderabad. The Bhir Secondary Series.*

This series connects the Khanpisura Series with the Great Arc, following the 19th parallel. It has a length of 176 miles and covers 2,764 square miles.

Twenty-six stations were visited, forming a chain of twenty-four simple triangles. The observations were made with an 8″ micrometer theodolite and show a mean triangular error of 0″·9.

### Madras.

*Districts of South Arcot and Salem. The Villupuram Secondary Series.*

A secondary series was completed along the parallel of 12°, extending from the Great Arc in longitude 77° 50′ to the South-East Coast Series in longitude 79° 20′. Its length is 99 miles and the 18 triangles composing it cover 1,106 square miles. The observations were made with an 8″ micrometer theodolite and give an average triangular error of 1″·77.

*District of Madura. The Madura Series.*

This series, of which only the building of stations has so far been accomplished, will be observed as a secondary series. It lies along the parallel of 10° between the Great Arc and the South-East Coast Series.

## Bombay.

*Bombay City. Triangulation network.*

To serve as an adjusting framework for a large scale survey of Bombay City, a network of triangulation is being gradually extended over the Island. It is based on a pentagonal figure, with sides some seven miles in length directly connected with the Bombay Longitudinal Series. The completed triangulation covers an area of 75 square miles.

## Kashmir.

*Russian connection. Hunza Valley.*

Mr. Wainright followed the course of the Hunza and Kilik rivers from Gilgit to the Kilik Pass. He found that the carrying of operations up this valley to points from which a junction with the Russian triangulation could be effected, though difficult, was feasible.

He reported that the pathway, good as far as Hunza, became very difficult in places between that place and Misgar, sometimes hung precariously on the face of precipices, sometimes crossing glaciers much serrated and crevassed.

The Hunza Valley having been found to be practicable, Lieutenant Bell's detachment has been occupied this hot weather in carrying a series of triangles along it from the head of the Kashmir Principal Series, towards either the Kilik or the Mintaka Pass. The latest information received points to Lieutenant Bell with one provincial officer having been at work in the neighbourhood of Misgar during the early part of July, while other officers of his detachment were occupied lower down the valley between Gilgit and Hunza.

Since writing the above I have learned with deep regret of Lieutenant Bell's death beyond the Kilik Pass.

## Teram Kangri.

At the time of submission of last year's report only preliminary values could be given of the position and height of Teram Kangri, the peak discovered by Dr. Longstaff in 1909.

These preliminary values were based on Mr. Collins' plane table work and an aneroid barometer. The triangulation, carried by him up to his stations of observation, has been now computed, giving the following results:—

Teram Kangri. Lat. 35° 34′ 37″. Long. 77° 07′ 31″. Height 24,489 ft.

## ASTRONOMICAL LATITUDES.

During the season 1911-12, latitude observations were made at eleven stations; one being in the Siwalik hills south-east of Dehra Dun, and the remainder on two triangulation series extending northwards from the line Ranchi-Lohardaga.

The reason for the selection of this locality was to attempt to define the position of the hidden chain of high density, the existence of which has long been suspected.

The values of the deflections of the plumb-line are as follows, the stations shown in italics having been observed at previously.

| Name of station. | Latitude. | Longitude. | Height. | Deflection of the plumb-line. |
|---|---|---|---|---|
| | ° ′ | ° ′ | Ft. | ″ |
| Mahwari . . . . . | 23 26 | 84 54 | 3,153 | +4·32 |
| Bulbul . . . . . | 23 38 | 84 26 | 3,352 | +8·81 |
| *Chendwar* . . . . . | 23 57 | 85 26 | 2,814 | +3·07 |
| *Hurilaong* . . . . . | 24 2 | 84 22 | 1,378 | +10·75 |
| Teona . . . . . | 24 35 | 84 10 | 740 | +10·82 |
| Mahar . . . . . | 24 44 | 85 10 | 1,606 | +10·24 |
| Behar . . . . . | 25 12 | 85 31 | 391 | +13·22 |
| Mednipur . . . . . | 25 5 | 84 22 | 335 | +8·32 |
| Nuaon . . . . . | 25 35 | 84 14 | 251 | +7·70 |
| Dubauli . . . . . | 25 40 | 85 20 | 189 | +6·76 |
| Jalalpur . . . . . | 26 4 | 84 23 | 232 | +6·14 |
| Pahladpur . . . . . | 26 4 | 85 27 | 175 | +6·23 |

A positive sign denotes a southerly attraction of the plumb-line.

Neglecting for the present the value at Bihar, the deflections north of latitude 24° decrease regularly, and though it may seem somewhat surprising to find southerly deflections at Jalalpur and Pahladpur within 100 miles of the outer Himalaya to the north, with flat plains stretching to a greater distance southwards, such deflections have been found before in similar localities and form the main evidence of the existence of the hidden chain of high density to the south, and the trough of low density under, or near the foot of, the Himalaya.

The small deflections at Mahwari and Chendwar seem to show that these stations are near to, and probably south of, the crest of the hidden chain, the comparatively high value at Bulbul being explained by its position on the extreme north edge of high ground. Latitude observations on the new series of triangulation now being executed south of Mahwari towards Sambalpur should prove of great geodetic interest.

The deflection at Bihar is the largest southerly deflection as yet discovered in India (that at Teona being the second) and the position of the station on a low hill rising only some 200 feet above the Gangetic plain precludes the possibility of a large correction for local topography such as exists at Bulbul. It seems likely, therefore, that the range of hills 12 to 15 miles south are of very great density, though unfortunately it was not possible to visit them.

Pendulum observations were made over the same area as the latitudes, and the results, which are dealt with elsewhere, show that gravity is probably in excess south of latitude 25°.

The station in the Siwalik hills, Khajnaur, is situated on a spur running north from the main range and the deflection found is somewhat less than at the four stations visited the previous year. This result seems somewhat contradictory, as in the last report the deflections on the crest and northern edge of the Siwaliks were stated to be larger than on the southern slopes. The deflections given therein were, however, provisional and the correct values are as given below:—

| Station. | Latitude. | Longitude. | Height. | Deflection of the plumb-line. |
|---|---|---|---|---|
| | ° ′ | ° ′ | Ft | ″ |
| Lachkua . . . . . | 30 4 | 78 2 | 2,674 | −28·90 |
| Bullawalla . . . . . | 30 7 | 77 59 | 2,432 | −28·97 |
| Hatni . . . . . | 30 13 | 77 52 | 3,096 | −29·59 |
| Shorpur . . . . . | 30 14 | 77 58 | 2,916 | −29·13 |
| Khajnaur . . . . . | 30 16 | 77 53 | 2,576 | −26·93 |

Until local topography has been allowed for it is idle to discuss these results, but in view of the fact that the deflection at the east end of the Dehra Dun base, some four miles north of Shorpur, is $-30''{\cdot}37$, the statement that the mass of the Siwaliks is probably not very great and of low density is probably correct.

## PENDULUM OPERATIONS.

During the season 1911-12 measurements of gravity were made at 12 stations in Bihar, Chota Nagpur and the extreme eastern portion of the United Provinces. The results are shown in the table.

The last seven stations are in the Gangetic plain and gravity is everywhere found to be in defect, the residuals $(g_o''-\gamma_o)$ increasing in the usual manner as the Himalayas are approached. At the first five stations gravity is more nearly normal, but, except at Daltonganj, has not been found to be in excess. A study of the deflections of the plumb-line observed in this area and referred to elsewhere in this report would, however, seem to show that the chain of high density has been crossed between Ranchi and Sasaram* and we should therefore have expected to find gravity considerably in excess at Japla, Daltonganj and Gaya.

The values of $(g_o''-\gamma_o)$ depend, of course, on the corrections for height and mass that we apply to the observed value of $g$. The correction for height is definite and unalterable and allows for the increased distance of the station from the centre of the earth. The correction for mass, however, depends entirely on the assumption of the existence or non-existence of isostasy. The corrections in the table are computed on Bouguer's hypothesis, that surface masses are not compensated by deficiencies of density. The corrections based on the theory of underground compensation have not as yet been computed for all the stations, but the following are the values of $g-\gamma$ that have been found at present:—

| Station. | $g-\gamma$ dynes. |
|---|---|
| Ranchi | +0·054 |
| Daltonganj | +0·050 |
| Japla | +0·027 |
| Gaya | +0·028 |
| Sasaram | +0·033 |
| Monghyr | 0·000 |
| Arrah | −0·003 |

* *Vide* deflections found at Mahwari, Teona and Mednipur under heading Astronomical Latitudes.

These values seem to fit in well with the theory of the hidden chain of high density, but discussion would be premature until the isostatic corrections for mass have been computed for more stations.

In the report for 1909-10 a table was published showing the values of $g$—$\gamma$ computed on Hayford's hypothesis, *i.e.*, that of underground compensation. These corrections were only computed up to a distance of 100 miles from the station, time not having been available for more than this; and to show that the values of $g$—$\gamma$ there exhibited will be sensibly altered when the correction is computed for the whole earth, it is only necessary to state that the correction beyond 100 miles from the stations already computed varies from 0·012 at Ranchi to 0·029 at Monghyr.

*Summary of results, 1911-12.*

| Station. | Latitude. | Longitude. | Height above M. S. L. | Observed $g$. | Correction for height. | Correction for mass. | Correction for terrain. | $g_o$=$c$. corrected for height only. | $g_o''$=corrected for height, mass and terrain. | $\gamma_o$. | $g_o-\gamma_o$ dynes. | $g_o''-\gamma_o$ dynes. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° ′ ″ | ° ′ | Ft. | | | | | | | | | |
| Ranchi . . . | 23 23 5 | 85 19 | 2,167 | 978·691 | +0·202 | −0·076 | 0 | 978·893 | 978·817 | 978·818 | +0·075 | −0·001 |
| Daltonganj . . | 24 2 5 | 84 4 | 707 | 978·827 | +0·066 | −0·025 | 0 | 978·893 | 978·868 | 978·861 | +0·032 | +0·007 |
| Japla . . . | 24 31 58 | 84 0 | 474 | 978·856 | +0·044 | −0·017 | 0 | 978·900 | 978·883 | 978·895 | +0·005 | −0·012 |
| Gaya . . . . | 24 47 42 | 85 0 | 361 | 978·884 | +0·034 | −0·013 | 0 | 978·918 | 978·905 | 978·913 | +0·005 | −0·008 |
| Sasaram . . . | 24 57 21 | 83 59 | 340 | 978·903 | +0·032 | −0·012 | 0 | 978·935 | 978·923 | 978·925 | +0·010 | −0·002 |
| Moghalsarai . . | 25 17 3 | 83 6 | 257 | 978·919 | +0·024 | −0·009 | 0 | 978·943 | 978·934 | 978·947 | −0·004 | −0·013 |
| Monghyr . . . | 25 22 53 | 86 28 | 154 | 978·909 | +0·014 | −0·005 | 0 | 978·923 | 978·918 | 978·954 | −0·031 | −0·036 |
| Arrah . . . | 25 34 10 | 84 39 | 188 | 978·918 | +0·018 | −0·007 | 0 | 978·936 | 978·929 | 978·967 | −0·031 | −0·038 |
| Buxar . . . | 25 34 42 | 83 59 | 207 | 978·933 | +0·019 | −0·007 | 0 | 978·952 | 978·945 | 978·968 | −0·016 | −0·023 |
| Muzaffarpur . . | 26 7 5 | 85 25 | 179 | 978·934 | +0·017 | −0·006 | 0 | 978·951 | 978·945 | 979·006 | −0·055 | −0·061 |
| Majhauli Raj . . | 26 17 46 | 83 58 | 219 | 978·928 | +0·020 | −0·008 | 0 | 978·948 | 978·940 | 979·019 | −0·071 | −0·079 |
| Gorakhpur . . | 26 44 58 | 83 23 | 257 | 978·936 | +0·024 | −0·009 | 0 | 978·960 | 978·951 | 979·052 | −0·092 | −0·101 |

## TIDAL OPERATIONS.

During the year tidal registrations by automatic tide-gauges have been continued at the following ports, with satisfactory results:—

Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein, and Port Blair.

## LEVELLING OPERATIONS.

During the year 1911-12 the following lines of precise levels were run:—

### (*a*) *In the Punjab.*

Shahpur to Sargodha.
Sargodha to Lahore.
Sargodha to Multan.

### (*b*) *In Assam.*

Dumpep to Sylhet.
Sylhet to Karimganj.
Karimganj to Silchar.
Karimganj to Comilla.

### (*c*) *In Burma.*

Minbu to Salin.

Salin along both sides of the Salin Chaung to the canal works.

Prome *viâ* Henzada and Maubin to Rangoon.

The line Magwe to Prome had been included in the programme, but it was not found possible to complete it. This line would have completed the first circuit formed in Burma. It is now intended to complete it in 1912-13.

In addition to the above lines of precise levelling some 235 miles of single levelling were carried out in the neighbourhood of Delhi, both as an aid for the surveying of contours for a map of Delhi and for the fixing of heights for engineering purposes.

## I.—BOTANICAL SURVEY.

BY

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**Eastern India.**—Since the publication of the last report two more fasciculi—comprising over 7,000 numbers—of the numerical list of non-herbaceous flowering plants cultivated in the Royal Botanic Garden, Calcutta, have appeared. This nominally completes the first volume of the catalogue, which contains over 13,400 numbers. These numbers indicate individual plants or groups only. The number of different species is much smaller. In the numerical list there are many blanks so far, of which palms constitute the large proportion. During the year, however, a fairly representative collection of specimens from the palms cultivated in the garden were sent to Dr. Beccari, the distinguished Italian botanist and authority on palms, and he has kindly identified them, so that it will be possible in the second volume to fill in many of the blanks. Considerable progress has been made in elaborating the materials for the second or systematic volume of the catalogue.

In the Eastern Himalaya collections were made on behalf of the Botanical Survey by Mr. B. J. Gould, I.C.S., Mr. W. R. Jacob of the Forest Department, Mr. R. S. Lister of Pashok Tea Estate, Mr. W. W. Smith, lately Curator of the Herbarium of the Royal Botanic Garden, Calcutta, and by Mr. G. H. Cave, Curator of the Lloyd Botanic Garden, Darjeeling. Mr. Gould's collections numbering about 400 sheets were made about Gyantse. Messrs. Jacob and Lister collected in Bhutan, the former contributing over 200 and the latter over 100 specimens of interest. Messrs. Smith and Cave's collections were made in Sikkim and the Darjeeling district, and supplemented by the collections made by the Lepcha collectors of the Lloyd Botanic Garden, Darjeeling, they totalled about 1,400 sheets. Mr. A. Meebold also presented the Calcutta Herbarium with a small collection from the outer hills of the Darjeeling district. J. F. Duthie has described the following new species of *Boraginaceæ* from the collections made in the Eastern Himalaya and the Tibetan tableland beyond by several officers during the Mission to Lhasa and by Calcutta Botanic Garden collectors:—*Paracaryum trinervium*,

*Eritrichium densiflorum, Microula pustulata, M. Younghusbandii, Onosma longiflorum, O. Waltoni, O. Waddellii.*

Mr. J. S. Gamble has cleared up the confusion hitherto existing as regards the differences between the different species of *Arundinaria* bambcos found on the hills of Sikkim, and has separated off as a new species—called *Arundinaria Maling*—a species that has hitherto been confounded with *A. racemosa*. Mr. Gamble has given a key to the 10 species of *Arundinaria* he recognises as occurring in Sikkim.

M. R. Hamet has described under the name of *Sedum Karpelesæ* a new species of *Crassulaceæ* collected by Major H. J. Walton, I.M.S., in the neighbourhood of Lhasa. Herr E. Koehne has described two new species of *Rosaceæ, Sorbus arachnoidea* and *S. Wenzigiana* and a new variety of *S. rufopilosa* from the Eastern Himalaya. From the same region Herr Herter has described a new species of Club moss as *Lycopodium sikkimense*, and Mr. H. N. Dixon a new moss, *Pogonatum papillosulum*. Messrs. Burkill and Finlow have described a new variety of the common jute plant *Corchorus capsularis* L. occurring in Eastern Bengal. In Assam Mr. I. H. Burkill while officiating during the hot weather of 1911 as Director of the Botanical Survey, toured in the Khasia Hills, accompanied by Mr. S. C. Banerji of the Botanical Survey Department. Their tour resulted in an accession to the Calcutta Herbarium of over 800 specimens. Towards the end of 1911, Mr. Burkill was deputed as botanist to accompany the Abor Expedition. Despite the unfavourable conditions, seasonal, climatic and otherwise, that greatly hampered botanical work, Mr. Burkill returned with over 2,000 specimens, which with his notes will serve to add very materially to our knowledge of the vegetation of that little known frontier region. Mr. Burkill has under preparation a detailed account of the botanical results of the expedition, which will appear in the Records.

Meanwhile the following extract from a general account of the Abor flora which was read by Mr. Burkill at the recent assembly of the British Association may serve to indicate the general characteristics of the vegetation.

"Forest is the natural clothing of the Abor hills, where it obliterates the clearings of man quickly; and where woody plants, following herbs, invade the less inviting spots (1) as epiphytes securing places in the tree-tops, (2) slowly spreading on to the rivers' sterile sandbanks, and (3) invading the river-beds between their June level and their January level. The lecturer used his time chiefly in studying the constitution of the different types of forest met with, and these three intrusions,

The Plains forest is in a way a northward extension of the vast forests of Malaya. Like all tropical rain-forests, it has a great variety of foliage. It has three layers—(1) the layer of the wind-dispersed, relatively small-leaved, giant trees; (2) the layer of the animal-dispersed, large-leaved lesser trees not growing beyond the still air; and (3) the layer of the ground vegetation wherein the plants are not large-leaved except in the alleyways of the forest. The second and third layers are separated by a light-diffusion space.

In their relation to creepers the trees of the forest differ in interesting ways: some thrive by outgrowing the creepers in annual spurts; some thrive by smothering them.

The Lower Hill forest is of two kinds. On the south slopes it is not unlike the Plains forest; but on the north slopes rules a most distinct and characteristic forest composed chiefly of a tree called by the Abors 'Shingkeng.' There is little variety in the foliage of a Shingkeng forest. Above the base of the hills oaks appear, and rule in places. On very steep slopes a giant bamboo rules. The Upper Hill forest has very uniform foliage, and is rather of two layers than three.

Grasses, as in the Sikkim forests, are very rare in the whole countryside; it is only where the very copious rain is drained away to an unusual extent that they can exist: thus, the very steep slopes harbour the giant bamboos; Abor clearings on hill-crests enable *Saccharum* to exist for a while; very well trodden paths in the immediate vicinity of villages allow two species to grow; sandbanks grow grasses; one invades the river-bed, clinging to rocks; and the gravel-beds at the foot of the hills after cultivation become covered with *Phragmites*.

Elsewhere grasses, even on clearings returning to jungle, do not exist. The clearings after the crop is removed are seized on by *Ageratum*, *Bidens*, *Blumea*, *Gnaphalium*, *Triumfetta*, *Viola*, etc. Then follow shrubs out of which a *Calophyllum* and a *Macaranga* gradually come to rule, the foliage getting larger as the height of the scrub increases, until finally it passes back to the true forest.

The river's clearings are sandbanks. Grass, first of all, takes possession of them; then slowly trees invade them, those which come first being the most deciduous species of the countryside.

The fall of the River Dehong in the hills is 50 to 60 feet. Of terrestrial plants, a moss ventures furthest into the exposed river-bed; not quite so far ventures a *Jungermannia;* a fern, an *Equisetum*, a *Polygonum*, and the curious Euphorbiaceous *Homonoia* descend to a

limit which has a longer period above the flood; another *Equisetum*, two other ferns, and *Rhabdia* of the Boraginaceæ descend half-way; the grass already mentioned, a *Lactuca*, a *Blumea* (Compositæ), *Viola Patrinii*, a *Ficus*, and some other plants occupy in increasing degree the upper part of the banks. The grass makes such a dense mat of roots as to resist the wash of the current and to hold a soil. The *Homonoia* is a tree with a trunk buried in the shingle.

Humid all the year round, it is only on the bluffs and south slopes of the Abor hills that trees bare after their leaf-fall for more than a month are found. Where bare trees stand, the epiphytes of the upper layers of the forest can be seen easily; they are more commonly in considerable aërial gardens than solitary, for the presence of one plant enables another to get a footing. As with the forest trees, the larger-leaved epiphytes are rarely in the topmost layers of the forest, but live a little below.

Mosses and film-ferns are abundant on the tree-trunks; neither store water, but both withstand desiccation. Two film-ferns were sent alive to Kew in a letter—a matter of a month in post-bags—without any protection against desiccation, and are now growing there.

Epiphytic figs are common in the forest, where the crown of one attains a greater span than other trees, and its roots find their way to the soil more than one hundred feet below.

The forest attains a height of 120 to 180 feet. Phanerogamic parasites are common in it, showy mistletoes living in the tree-tops, and leafless parasites being common on the ground, such as the coral-red *Balanophora dioica* and brown *Rhopalocnemis phalloides* (Balanophoraceæ) and dark blood-red *Sapria bengalensis* (Cytinaceæ), which live on the giant vines, where these, running through the tree-tops, make the light on the ground below too dim for foliage plants."

From Mr. Meebold's previous Manipur and Naga collections, M. C. deCandolle has described the following new species of *Piper*:—*P. phalangense*, *P. lainatakanum*, *P. kapruanum*, *P. aurorubrum*, *P. makruense*, *P. Meeboldii*, *P. nagaense*. From the same collections, a new species, *Raphidophora manipurensis*, has been described by Dr. Engler and Herr Krause, while from the same region but from Sir George Watt's collections Herr Krause has described *Sorbus Wattii* as a new species. Mr. W. W. Smith has described *Craibiodendron Mannii* as a new species from the Jaintia Hills.

In Burma Captain S. M. Toppin, R.G.A., made a botanically important journey in company with the Khampti Long Mission during

December 1911 and January and February 1912. The route was from the confluence of the Mali Hka and N'mai Hka rivers to form the Irrawaddy, northwards along the region west of the Mali Hka to Patau, thence north-eastwards to the Nam Tamai or upper waters of the N'mai Hka, the easterly of the two rivers that unite to form the Irrawaddy. The area covered lies roughly between 26° and 28° N. Lat. and 97° and 98° E. Long. Captain Toppin's collections are now being worked out. In addition to the collections much interesting information has been furnished by Captain Toppin in his notes. An account of the botanical results of both his journeys will be published as soon as opportunity permits, but a few of Captain Toppin's notes may be given here. The area west of the Mali Hka, between 26° and 27° N. Lat., consists of low ranges of hills running from west to east, covered with evergreen forest mostly composed of species of oaks and *Castanopsis*, with an undergrowth of prickly palms, bamboo thickets, plantains, and an abundance of *Strobilanthes* and *Impatiens*. Begonias also were common. Further north the hills are higher but the general aspect of the vegetation not markedly different. The species of oaks appeared to be different and a Rhododendron was found. There was practically a complete absence of Balsams and but few *Strobilanthes*. No coniferæ were seen. North of 27° 15′ N. Lat. and west of the Nam Kiu tributary of the Mali Hka is the grassy plain of Khampti Long. This plain is at an elevation of 1,100 to 1,200 feet and is completely covered with tall thatch grass, the trees being confined to edges of ravines that run from west to east, and to a few isolated knolls. Captain Toppin's collections on this journey were therefore from three distinct areas, (*a*) the part of the Kachin region that occupies the west side of the valley of the Mali Hka; (*b*) the Khunnong area around the headwater of the Mali Hka and N'mai Hka, being east of the Nam Kiu tributary of the Mali Hka and north of 17° 15′ N. Lat.; (*c*) the Khampti Long plain, north of 27° 15′ N. Lat., and west of the Nam Kiu tributary of the Mali Hka. Captain Toppin's explorations cover the area to the west of the region explored by Lieutenant Pottinger, R.A., in 1897, the explorations of the latter having been mostly confined to the eastern side of the N'mai Hka valley, which as is now known—although it was unknown at the time of Lieutenant Pottinger's expedition—does not come within the proper Kachin Hill area.

In Lower Burma Mr. A. Meebold explored part of the district of Mergui in the spring of 1911, and in the end of 1911 and beginning of 1912 made a tour in the districts of Thaton and Salween, travelling beyond

Papun in the latter district. From the three districts mentioned Mr. Meebold has contributed some 2,500 sheets to the Calcutta Herbarium. Smaller collections were contributed by Captain R. H. Phillimore, R.E., from the Southern Shan States, and by Mr. C. G. Rogers, Conservator of Forests, from Pegu. Amongst them and previous collections made in Assam and Burma quite a number of new species have been discovered, though all have not yet been published. Descriptions of the following have, however, appeared:—*Paradombeya multiflora, Elæocarpus Robertsoni, Lespedeza sessilifolia,* and *Beilschmiedia Robertsoni,* all from the Southern Shan States by Mr. Gamble; *Gentiana Hesseliana,* originally collected by Parish at Moulmein by Herr Hosseus; *Bulbophyllum congestum* from the Kachin (Maru?) hills by Mr. Rolfe; *Hibiscus Watsoni, Hedyotis glauca, Styrax Lacei, Staurogyne shanica, Didymocarpus Burkei, Craibiodendron Mannii* (all from Assam or Burma) by Mr. W. W. Smith; *Fimbristylis Lacei* (Burma) by Mr. Turrill. Mr. J. S. Gamble has continued his work on the Flora of the Malayan Peninsula, a region which comes within the area treated in the "Flora of British India," and during the year there has appeared an account of the families *Nyctaginaceæ, Amarantaceæ, Polygonaceæ, Aristolochiaceæ, Chloranthaceæ, Lauraceæ* and *Hernandiaceæ,* all being worked up by Mr. Gamble, except *Polygonaceæ,* the account of which was contributed by the writer of this report. M. Casimir deCandolle has published in the Records of the Botanical Survey diagnoses of the following new species of *Peperomia* and *Piper* from the Malayan Peninsula:—*Peperomia kotana, P. Maxwellana, P. Wrayi; Piper bipedale, P. collinum, P. connibaccum, P. curtipetiolum, P. Curtisii, P. dindingsianum, P. erecticaule, P. eucalyptolimbum, P. febrifugum, P. filipes, P. flavibaccum, P. flavimarginatum, P. flavispicum, P. globulistigmum, P. gymnocladum, P. gymnophyllum, P. kotanum, P. Kunstleri, P. larutanum, P. longamentum, P. longibracteum, P. longicaule, P. magnibaccum, P. malaccense, P. Maxwellanum, P. minutistigmum, P. mucronatum, P. muricatum* forma *peninsulare, P. pilistipes, P. nigrantherum, P. obovantherum, P. paucistigmum, P. pentandrum, P. polygynum, P. protractum, P. puberulirameum, P. ramipilum, P. varispicum, P. Ridleyi, P. rufibracteum, P. rufispicum, P. Scortechinii, P. selangorense, P. semaingkoanum, P. subalbicans, P. subfragile, P. subrubrispicum, P. subsessililimbum, P. velutinervium, P. xanthocarpum.* Other species from this region described since last report include *Wikstræmia Ridleyi, Henslowia monticola, H. Ridleyi, H. Wrayi, Scleropyrum Ridleyi,* by Mr. Gamble; *Strychnos pseudo-tieute* by Mr. A. W. Hill; *Lecanorchis Ridleyana* by Herr R. Schlechter.

**Southern India.**—Mr. C. E. C. Fischer, Deputy Conservator of Forests, has been the main support of Botanical Survey work in the peninsula. He has contributed over 1,200 specimens collected in various parts of the Madras Presidency, such as the Pulney and Anamalai Hills and in Coimbatore district. Mr. Fischer's large and excellently preserved collections will prove of great value when the Flora of the Madras Presidency comes to be written. Dr. C. A. Barber, D.Sc., Government Botanist, has given as much of his time to systematic work as his other engrossing duties permitted. The following is quoted from his report as Government Botanist for 1911-12:—

"*Systematic Botany.*—A considerable amount of attention was devoted to this section during the year because of the decision on the part of the Government to have a flora of the Madras Presidency prepared, and numerous reports were forwarded on the subject. There was practically no special touring for the collections of plants, but substantial additions were made to the collections of peppers and *Loranthaceæ* by the Government Botanist while on other tours and a few local expeditions were made by fieldmen. Much progress was made in getting the large accumulation of plants, collected in previous years by the Government Botanist named, although this work was still hampered by lack of staff and the absence of suitable herbarium cases. Some 7,700 sheets were finally written on and added to the special collection of Madras plants. Eighty duplicate sheets were received from the Calcutta Herbarium. A small herbarium of 250 species of plants was given to the Presidency College for teaching purposes and about 50 sheets were distributed to other correspondents. The whole collection of *Dioscoreas* was sent to the Reporter on Economic Products and named and returned by him. The valuable collection of *Grewias* remained with the Kew authorities throughout the year. An important addition was made to the illustrations of the Madras flora in the form of 513 pen and pencil drawings of plants. On investigation these turned out to be the originals of the plates in Wight's, Beddome's and other authors' published works on the Madras flora. They were received in an extremely dilapidated condition, but every effort is being made to preserve them in a series of specially prepared atlases. About 200 plants were named by the Assistant for various correspondents. The collection of 1,143 sheets of Madras peppers was overhauled by the Government Botanist and numerous dissections and drawings made. The specimens were sorted, arranged and named where possible and notes were drawn up for the information of the writer of the flora. A summary note on this work was prepared and forwarded for filing at Kew. The seed collection

was overhauled and it was found necessary to reject a large number on the ground of insufficient naming. About 280 new species were, however, added, so that the number at the end of the year was 600."

The following new species from this area has been published during the year:—*Decaschistia rufa* (*Malvaceæ*) by Mr. W. G. Craib.

**Western India.**—Although there is not now so much scope for exploration on the western as on the eastern side of the Indian Empire, there is abundant opportunity for study of the vegetation from the standpoint of particular orders, genera or species as distinct from the study of the vegetation of any definite geographical area. Both aspects of study are comprehended in Mr. W. H. Talbot's Forest Flora of the Bombay Presidency and Sind, the second volume of which—comprising descriptions and distribution of the forest species of the families *Rhizophoreæ* to *Gramineæ*—has appeared during the year. In this volume 526 species belonging to 247 genera and 51 orders are described. The richest orders are *Euphorbiaceæ* with 66, *Rubiaceæ* with 48, *Urticaceæ* with 36, *Acanthaceæ* with 34, *Convolvulaceæ* with 28, and *Apocynaceæ* with 24 species. The flora of Aden has been made for some years the subject of thorough study by the Rev. Father E. Blatter, S.J., who has now made ready for publication an exhaustive account of the vegetation, comprising the history of the botanical exploration of the region, the physical aspects of Aden, a statistical account of the vegetation, its general aspects, adaptations, flowering season and climate, geographical relations, origin, dissemination, together with a synopsis of the families and descriptions of the species. Altogether 250 species are described, nearly thrice as many as were mentioned by Anderson in his "Florula Adenensis" published about half a century ago. Arrangements have been made for the Botanical Survey Department to publish during the coming year this valuable contribution to the botany of the Indian Empire.

Mr. G. A. Gammie has issued a further instalment of his description of the *Orchidaceæ* of the Bombay Presidency, comprising the species of the genus *Peristylus*.

Mr. R. K. Bhide, Assistant Economic Botanist, Bombay, has published description of the following new species of grasses found in the Bombay Presidency:—*Danthonia Gamniei*, *Andropogon Paranjpyeanum*, *Enteropogon badamicum*, *Tripogon Roxburghianum*. The following new species or varieties of *Piper* collected by Mr. Meebold in Western India have been described by M. Cas. deCandolle:—*Piper*

*crenulatibracteum* (North Kanara), *P. nigrum* L. var. nov. *mysorensis* (Mysore), *P. hymenophyllum*, form. nov. β (Mysore), *P. Talbotii* (Matheran). Mr. S. A. Watson, I.A., of of the 67th Punjabis has presented collections made by himself in the neighbourhood of Kach in Baluchistan. Mr. H. N. Dixon has described a new genus and species of moss *Bryosedgwickia Kirtikarri* from the Bombay side.

**Northern India.**—Colonel J. C. Bamber, I.M.S., has issued another part of his key to the flora of the Punjab, North-West Frontier and Kashmir. Lady Douie presented the Calcutta Herbarium with collections made by herself and by Mr. K. S. Imam-ud-din of the Forest Department in Kulu and Pangi respectively. Mr. J. H. A. Ivens has studied and recorded the general seasonal and altitudinal aspects of the flora of the vale of Kashmir. From the North-West Himalaya the following new species have been described:—*Leontopodium Evax*, *L. Jacotianum* by M. Beauverd; *Corydalis Onobrychis* (from Gilgit) by M. Fedde; *Sorbus Wenzigiana* (from Kumaon), and three new varieties of *S. cashmiriana* Hedbund by Herr Koehne; *Lespedeza dubia*, *L. indica*, *L. Meeboldii* by Herr Schindler; *Cynanthus cordifolius* by Mr. J. F. Duthie; *Lindbergia longinervis* (a new moss) by Mr. H. N. Dixon. The area of distribution of *Philonotis seriata* Mitten, a moss hitherto supposed to be confined to Europe and North America, has been extended by the recognition of its occurrence in the North-West Himalaya.

**Additions to the known Flora.**—During the year over a hundred hitherto undescribed species have been added to the number known to occur within the area covered by the "Flora of British India."

**General systematic.**—The Rev. Father Blatter, S.J., has compiled a very useful bibliography of the Botany of British India and Ceylon. The compilation is in two parts—(I) a general bibliography containing the titles of publications that treat of the Botany of India in general or of a greater part of India, (II) a regional bibliography that enumerates the books and papers dealing with the botany of smaller areas included wholly or partly in one of the botanical regions at present recognised in India. In all over 1,500 books and papers are cited. Parts V and VI of the same botanist's account of the palms of British India and Ceylon, indigenous and introduced, have appeared during the year, the species described belonging to the genera *Corypha*, *Nannorhops*, *Licuala*, *Livistona*, *Pritchardia*, *Washingtonia*, *Sabal*.

Considerable progress has been made towards the publication of the supplement to Doctor Beccari's account of the species of the genus *Calamus* of climbing palms. The same author has published a classification of the

palms of Indo-China. Mr. J. R. Drummond, I.C.S. (retd.), has published an elaborate and valuable critique of the Indian species of *Grewia* as understood, described or mentioned by Roxburgh. M. Gagnepain has revised the classification of the Asiatic species of *Buddleia*. Sir David Prain has critically revised the history, classification and distribution of the species of *Erythrococca* and *Micrococca*. His review is of importance to students of Indian botany from the occurrence of species of the latter genus in India. Herr Schottky has published an account of the oaks and allied genera of Eastern Asia and their geographical distribution. The Asiatic species of *Aponogeton*, *Paspalum* and *Panicum* have formed the subject of papers by M. Camus. The distribution and use of *Erythrina indica* Lamk. in Indo-China has been discussed by MM. Dubard and Eberhardt.

Mr. S. T. Dunn has published an account of *Primula bellidifolia* King and its allies, with a key to the group formed by that species and nine others. Papers of a more general systematic character, that in part directly or indirectly have a bearing on the botany of India, are mentioned in the list of publications at the end of this article.

**Anatomical and physiological.**—Professor Bower of Glasgow University has based one of his recent studies in the Phylogeny of the Filicales, *viz.*, "On *Lophosoria* and its relation to the *Cyatheodeæ* and other ferns," partly on material supplied by the Calcutta Botanic Garden. The same Garden supplied in part the material for an investigation by Mr. R. C. Davie into the structure and affinities of *Peranema* and *Diacalpe*, two Eastern Himalayan forms. Mr. I. H. Burkill has recorded a series of observations on the polarity of the bulbils of *Dioscorea bulbifera* L. as regards the sprouting of shoots. Mr. W. Burns has described a second year's growth of a plantain inflorescence.

Other investigations on anatomical or physiological lines with more or less application to Indian botany are mentioned in the list of papers appended.

*A list of papers containing references to the Botany of India published mostly during 1911-12.*

BAMBER, C. J. . . Plants of the Punjab, IX. (*Journ. Bomb. Nat. Hist. Soc., xxi, No. 1, 1911, p. 203-228.*)

BEAUVERD, G. . . Sur la distribution géographique des genres *Leontopodium* Cass. et *Cicerbita* Wallr. Emend. Beauv. (*Bull. Murithienne, xxxvi, 1911, pp. 44 and 77.*)

BEAUVERD, G. . . Nouvelles especes eurasiatiques du genre *Leontopodium.* (*Bull. Soc. Bot. Genève, 2nd Ser., i, p. 185-196, 1909.*)

BECCARI, O. . . Classification des Palmiers d'Indo-Chine. (*Bull. Mus. Nat. d'Hist. Nat., 1911, No. 3, p. 148-160.*)

BENOIST, R. . . Les genres *Lepidagathis* et *Lophostachys* sonts-ils distincts? (*Notulæ Systemat., ii, No. 5, 1911, p. 139-144.*)

,, Contribution à la flore des Acanthacées asiatiques. (*Notulæ Systematicæ, ii, No. 8, 1912, p. 238-240.*)

BHIDE, R. K. . . New and revised species of *Gramineæ* from Bombay. (*Journ. Asiat. Soc. Beng., vii, No. 8, 1911, p. 513-520, with 4 plates.*)

BLATTER, E. . . A Bibliography of the Botany of British India and Ceylon. (*Journ. Bomb. Nat. Hist. Soc., xx, No. 5, 1911, p. lxxix-clxxxv.*)

,, The Palms of British India and Ceylon, Indigenous and Introduced, V and VI. (*Bomb. Nat. Hist. Soc. Journ., xxi, Nos. 1 and 2, 1911-1912, p. 66-86 and 343-391, with 15 plates.*)

BONAVENTURA, C. . Ricerche anatomiche súl fiore delle Orchidee. (*Nuovo Giorn. Bot. Ital., xix, 1912, No. 2, p. 167-293, with 4 plates.*)

BOWER, F. O. . . Studies in the Phylogeny of the *Filicales*. *Lophosoria* and its relation to the *Cyatheoideæ* and other ferns. (*Ann. Bot., xxvi, 1912, No. 102, p. 269-323, with 7 plates.*)

BURKILL, I. H., & FINLOW, R. S. *Corchorus capsularis* var. *oocarpus*, a new variety of the common jute plant. (*Journ. Asiat. Soc. Beng., vii, 1912, No. 8, p. 465-466.*)

BURKILL, I. H. . Polarity of the bulbils of *Dioscorea bulbifera* L. (*Journ. Asiat. Soc. Beng., vii, 1912, No. 8, p. 467-469.*)

,, The Forest of Kobo. (*Kew Bull., 1912, p. 159.*)

BURNS, W. . . Second year's growth of a plantain inflorescence. (*Journ. Bomb. Nat. Hist. Soc., xxi, 1912, No. 2, p. 706-707.*)

CAMUS, A. . Note sur les éspeces asiatiques du genre *Aponogeton*. (*Notulæ Systematicæ, ii, 1912, No. 7, p. 202-204.*)

,, Note sur les *Paspalum* de l'Asie orientale. (*Not. System., ii, 1912, Nos. 7 and 8, p. 216-226.*)

,, Notes sur quelques *Panicum* de l'Asie orientale. (*Notulæ Systematicæ, ii, No. 8, 1912, p. 246-253.*)

CANDOLLE, DE, C. . *Piperaceæ Meeboldianæ* Herbarii Vratislaviensis. (*Repert. spec. nov. Reg. Veget., x, 1912, Nos. 266-270, p. 518-523.*)

,, Piperaceæ novæ a Peninsula Malayana. (*Rec. Bot. Surv. Ind., vi, 1912, p. 1.*)

COLOZZA, A. . Contributo allo studio anatomico delle *Burmanniaceæ*. (*Bull. Soc. Bot. Ital., 1910, p. 106-115.*)

CRAIB, W. G. . *Decaschistia rufa*. (*Kew Bull. No. 1, 1912, p. 35.*)

DAUPHINÉ, A., & HAMET, R. Contribution à l'étude du genre *Kalanchoe*. (*Ann. Sc. Nat. 9, Ser. Bot., xiv, 4-6, p. 195-219.*)

DAVIE, R. C. . The structure and affinities of *Peranema* and *Diacalpe*. (*Annals of Botany, xxvi, No. 92, April 1912, p. 245-268, with 2 plates.*)

DISMIER, G. . Sur la presence du *Philonotis seriata* Mitten en Asie. (*Bull. Soc. Bot. de France, lix, 1912, p. 175-177.*)

DIXON, H. N. . *Bryosedgwickia*, novum genus *Entodontacearum*, with further contributions to the Bryology of India. (*Journ. Bot., l, No. 593, 1912, p. 145-156, with 1 plate.*)

DOMMEL, H. C. . Ueber die Spaltöffungen der Gattung *Euphorbia*. (*Ber. deutsch. bot. Ges., xxviii, 3, 1910, p. 72-77, with 1 plate.*)

DRUMMOND, J. R. . The Grewias of Roxburgh. (*Journ. Bot., xlix, Nos. 587 and 588, 1911, p. 329-337 and p. 357-363.*)

DUBARD, M. . Remarques sur la classification des Sidéroxylées. (*C. R. Acad. Sc. Paris, cvii, 1911, p. 390-393.*)

DUBARD, M., & EBERHARDT, PH. — *L'Erythrina indica* Lamk. en Indo-Chine. (*Bull. Mus. Nat. Hist. Nat., 1910, No. 6, p. 333-337.*)

DUNN, S. T. — *Primula bellidifolia* King, and its allies. (*Notes from the Roy. Bot. Gard. Edinburgh, No. xxiii, 1911, p. 61-64, with 1 plate.*)

DUTHIE, J. F. — Diagnoses of new Indian species. (*Kew Bull. No. 1, 1912, p. 37-41.*)

ENGLER, A., & K. KRAUSE. — *Raphidophora maniputensis.* (*Bot. Jahrbüch, xlv, 5, 1911, p. 659.*)

ESENBECK, F. — Ueber die Systematik der Gattung *Melampyrum.* (*Mitteil. bayr. bot. Ges. Erforsch. heim. flora, ii, 4, p. 239.*)

FEDDE, F. — *Corydalis Onobrychis*, eine neue Art aus Kaschmir, aus der Verwandtschaft der *C. astragalina.* (*Repert. spec. nov. Reg. Veget., x, 1912, Nos. 266-270, p. 565.*)

GAGE, A. T. — *Polygonaceæ*, in "Materials for a Flora of the Malayan Peninsula, No. 22." (*Journ. Asiat. Soc. Beng., lxxv, Pt. I, 1912, p. 18-23.*)

" — Catalogue of non-herbaceous Phanerogams cultivated in the Royal Botanic Garden, Calcutta. Part I. Numerical List. 3rd and 4th Fasciculi. (*Rec. Bot. Surv. Ind., v, Nos. 2-4, p. 169-367.*)

GAGNEPAIN, L. F. — Revision des Buddleia d'Asie. (*Notulæ Systematicæ, ii, 1912, Nos. 6-7, p. 182-194.*)

GAMBLE, J. S. — Materials for a flora of the Malayan Peninsula, No. 22. (*Journ. Asiat. Soc. Beng., lxxv, Pt. I, 1912, p. 1-204.*)

" — The Arundinarias of the Hills of Sikkim. (*Kew Bull., 1912, No. 3, p. 135-140.*)

" — Diagnoses of new species in "Decades Kewenses." (*Kew Bull., 1912, No. 4, p. 198-202.*)

GAMMIE, G. A. — Orchids of the Bombay Presidency, XII. (*Journ. Bomb. Nat. Hist. Soc., xxi, No. 1, 1911, p. 171-174, with 1 plate.*)

GIBBS, L. S. — On the development of the female strobilus in *Podocarpus.* (*Ann. Bot. xxvi, No. 92, 1912, p. 515-571, with 5 plates.*)

GOEZE, E. . . Zur Geschichte der *Prunus* und *Pyrus* Arten. (*Oesterr. Gartenr., vi, 1911, No. 3, p. 87-90; No. 4, p. 137-142; No. 5, p. 180-186.*)

GUIGNON, J. . . Le genre *Euonymus*. (*La Feuille des J. Natur., xli, 1911, p. 70-73.*)

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HAMET, R. . . Observations sur la germination des Crassulacées. (*Bull. Soc. Bot. France, lviii, 1911, Mem. 21, p. 13.*)

,, *Sedum Karpelesæ*. (*Bull. Soc. Bot. de France, lviii, 1911, p. 615-617.*)

HERTER, W. . Beitrage zur Kenntnis der Gattung *Lycopodium*. (*Bot. Jahrb., xliii, 98, p. 1-56, 1909.*)

HILL, A. W. . . *Strychnos Ignatii* and other East Indian and Philippine species of *Strychnos*. (*Kew Bull., 1911, No. 7, p. 281-302, with 2 plates.*)

HOOKER, J. D. . . On some Western Peninsular Indian Balsamineæ collected by Mr. A. Meebold. (*Kew Bull. No. 9, 1911, p. 353-356.*)

,, Icones Plantarum, X, Pt. III, Tab. 2951-2975. [Description and plates of new species of Impatiens.]

HOSSEUS, C. O. . Eine neue *Gentiana* (*G. Hesseliana* Hoss.) vom Pahombukgebirge (2300 m. ü. de M.) auf der Siamesisch-birmanischen Grenze. (*Repert. nov. spec. Reg. Veg., ix, 1911, Nos. 27-31, p. 465-466.*)

HUME, E. M. M. . The histology of the sieve tubes of *Pteridium aquilinum*, with some notes on *Marsilia quadrifolia* and *Lygodium dichotomum*. (*Ann. Bot., xxvi, 1912, p. 573-587, with 2 plates.*)

IVENS, J. H. A. . Notes on the flora of the Vale of Kashmir. (*Journ. Bomb. Nat. Hist. Soc., xxi, 1912, No. 2, p. 701-705.*)

JOHNSON, D. S. . . Studies in the development of the *Piperaceæ* I. (*Journ. Exper. Zool., ix, p. 715-749, figs. 1-71, 1910.*)

KAWAMURA, S. . On the cause of the flowering of bamboos. (*Bot. Mag. Tokyo, xxv, 1911, p. 273-269.*)

KIRTIKAR, K. R. . A note on *Trichosanthes dioica* Roxb. (*Journ. Bombay Nat. Hist. Soc., xxi, 1912, No. 2, p. 700-701.*)

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## II.—ECONOMIC BOTANY.

### Part I.—AGRICULTURAL BOTANY.

BY

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The present report deals with the progress of Agricultural Botany in India during the year ending June 30th, 1912, and is confined to the results actually obtained. All references to current programmes of work are omitted as these are to be found in the *Proceedings of the Board of Agriculture for 1911*, which has already been published. In the present paper, the subject of seed distribution in India has been dealt with in a separate section, in order that the significance of the great progress made in this direction by the Agricultural Department may be appreciated. A list of papers published during the year is appended.

### I. SEED DISTRIBUTION.

Since the foundation of the Agricultural Department of India in 1905, a considerable amount of attention has been paid to the improvement of the cultivated plants of the country. New crops have been introduced and better varieties of existing staples have been brought to the notice of the people, coupled often with improved methods of cultivation. The success of these efforts has in turn raised the question of the best means of maintaining and distributing pure seed of improved varieties of crops and this matter was one of the subjects discussed at the recent meeting of the Board of Agriculture held at Pusa in November 1911. The report of the Committee, which was adopted by the Board, is published in the *Proceedings of the Board of Agriculture for 1911*, and deals with the methods of obtaining improved varieties, the testing of varieties, the maintenance of pure types, the distribution of seed to cultivators and with the marketing of the produce. In this work stress was laid on the importance of natural cross-fertilization in crops like cotton and also on the maintenance in pure culture, by the Botanist in each Province, of a collection of the improved types introduced by the local Department. This collection will serve both as a source from which pure seed can be obtained for re-stocking the seed farms and also for the use of investigators in other Provinces. In the distribution of

seed to cultivators it was recommended that the following main principles should guide the work of the Agricultural Department:—

1. The desirability of concentrating the efforts of the Department on one or two well-defined problems at a time rather than wasting its resources on indiscriminate seed distribution.

2. The desirability of confining the work of seed distribution in any one tract as far as possible to one sort and of systematically replacing existing mixtures by this pure type. This is particularly necessary in the case of cross-fertilized plants where degeneration through vicinism is of such great importance. The distribution of one sort only has the further advantage of creating large supplies of one particular type and thus forming a trade centre for this produce and attracting buyers.

3. The necessity of utilizing to the utmost the present staff and resources of the Department and of supplementing this by enlisting the assistance of leading agriculturists in the work of seed growing and seed distribution in the tracts concerned.

This discussion of the general subject of seed distribution in India by the Board of Agriculture by no means implies that nothing useful in this direction has been accomplished. On the contrary, the results already obtained are most gratifying and the present opportunity is taken of drawing attention to the most important. The crops in which most progress has been made are cotton and wheat and these are dealt with in the following paragraphs.

**Cotton.** The distribution of improved seed of a crop like cotton, in which natural cross-fertilization is common, in such a manner that the improvement in the staple can be maintained permanently is a problem of the greatest interest in agricultural science. On this account the efforts of the Agricultural Department in this direction are described in some detail. It is clear that if this work is to be of lasting benefit to India the present cottons in any tract must be entirely replaced by one kind, which breeds true to type, in order that the results of vicinism may be prevented and the mixing of seeds at the ginneries rendered impossible.

The improvement of the cotton crop in Madras is one of the chief features of the work of the Provincial Agricultural Department. Not only have selection methods been applied successfully to the local cottons, but an exotic cotton, known as Cambodia, has been widely taken up by the cultivators.

In the selection work the results obtained by Mr. Sampson with Karanganni cotton in Tinnevelly are the most interesting and the most

important. This work was commenced at the Koilpatti farm some years ago and the area now under the improved cotton is upwards of 80,000 acres. The methods first adopted in the improvement of Karanganni cotton come under the term mass selection, that is to say, the culture was started from several plants. These were selected for their shape and bearing power from the general farm crop. In the third year, the seed was issued to contract growers who cultivated it under instructions from the Department. The whole crop was then sold back to the Department, who ginned the *kapas* and next year distributed the seed to depôts in the black cotton soil villages where it was sold to cultivators. These depôts are selected every year and the depôt is moved to a fresh place as soon as Karanganni cotton has been established as a pure crop. In this way the whole area suited to this cotton will be worked over and the existing cottons will be replaced by the improved kind. Recently the methods of selection have been improved at Koilpatti and at the present time the cultures are started from one plant. Such pure line cultures have already reached a field scale and during the present year one of these will be grown on a seed farm. The method of conducting the pure line cultures is as follows: In the second year culture the crop from each plant is collected separately and the lint is examined for twist, evenness, length and fineness and the ginning percentage is also determined. The best and most even plants only of this culture are taken for seed and these are grown as a field crop on a plot one-tenth of an acre in area so that the behaviour of the selection under ordinary field cultivation can be estimated. If the crop is even and suitable in the third year it is planted on an acre plot, after which the cotton is sampled and tested, and, if suitable, carried on to a seed farm. At each stage selections which prove undesirable are discarded and an approximation to a pure culture is obtained in this way and cross-fertilization is to a great extent prevented. Mr. Sampson states that cross-fertilized plants disclose themselves by the following characters: by increased vigour; by increased length of the staple; by increased difficulty in ginning—a selection in which there is difficulty in removing the lint from the seed is always open to suspicion. Variation in the colour, shape and fuzziness in the seed of the progeny of a selection is also a useful indication of natural crossing. The area of the seed farms in Tinnevelly under Karanganni in 1910-11 was 574 acres which gave seed enough for 11,200 acres and it was sold for Rs. 10 per 250 lbs. There was great competition for the seed and it is interesting to note that the Tuticorin Chamber of Commerce states that the improvement in the quality of this cotton is still maintained. As the selection methods at the Koilpatti farm progress there is little doubt that

still better cotton will be produced for the seed farms and in this way successive waves of cotton will proceed outwards from the agricultural station resulting in the establishment of a definite improvement.

In the Northern Circle of the Madras Presidency similar methods of selection and seed distribution with cotton have been started, the preliminary results of which appear to be of considerable promise.

In the case of Cambodia cotton the results obtained in Madras are, on the whole, not so satisfactory as with Karanganni. Cambodia cotton, which is grown only on irrigated garden lands, continues to spread and in the south of the Presidency the crop is estimated at 80,000 bales as against 33,000 bales the previous year. In addition it has been tried further north in Bellary, Kurnool and other Districts and has been a success everywhere. Over 31,000 lbs. of seed were sold by the Department last year and a still larger stock will be held in future. The yield per acre is as good as ever but the price has dropped to the level of Tinnevelly or even lower. This is said to be due not only to the fact of the cheapness of long stapled American, with which Cambodia competes, but also to a deterioration in quality of which most of the mills complain. The subject has received the careful attention of the Director of Agriculture who states that this deterioration is due to some extent to fraudulent admixture with country cotton, but mainly to the carelessness of the ryot who sows mixed seed and who will not trouble to eradicate the country cotton plants from his Cambodia crop. Some of the deterioration may be due to fraudulent admixture with country seed by the private growers who are growing the Cambodia mainly for seed purposes. The Madras experience with Cambodia is not surprising considering the rapidity of the spread of this cotton by private agency and the fact that most of the seed supply was not controlled by the Agricultural Department. It is a valuable lesson to all concerned with the establishment of high quality cotton in India. To bring about any permanent improvement in such cottons it is necessary to replace systematically all the existing cottons in a tract by one type as is being done in Tinnevelly. This replacement to be effective must obviously be controlled by the Agricultural Department and it is clear that this will take time, especially when the size of the staff and the means of the Department are considered. There must always be a risk of fraudulent adulteration of seed if the seed supply is not under strict control and it would seem to be better to work in one or two Districts at a time in future than to allow the cotton to spread itself. Only in this way can the consequences of natural crossing, of mixing of seed at ginneries and of fraudulent admixture be prevented.

In the Central Provinces, the chief centre of cotton seed distribution is situated at Akola in the middle of the cotton tract, where the work has been organised by Mr. Clouston, Deputy Director of Agriculture, Southern Circle. The principal types distributed have been obtained by selection from the Berar *Jari* and high quality long stapled cottons like *Buri* are distributed only to rich village lands and in those areas where cotton is generally affected by wilt. The selected constituents of the *Jari* mixture are short stapled cottons, characterised by high yield, high ginning percentage and robust growth under ordinary conditions and it has been found that these types pay the cultivator best. From the Akola farm as a centre, a system of seed distribution has been developed by Mr. Clouston on the following lines. Leading landowners, who are also members of the Agricultural Associations, are selected as suitable men to look after the local private seed farms and at the beginning the Government guaranteed to these men to make up any loss resulting from the improved methods of cultivation and the growth of seed which the Agricultural Department recommended. The selected seed from the Akola farm is sold to these private seed farms and the owners themselves arrange for its sale and distribution. The supervision of the Agricultural Department is confined to cultivation, ginning and advertising the seed in the monthly vernacular journal, which has a circulation of about 6,000 copies. The chief difficulty experienced has been that of getting the seed ginned at the proper time and of preventing mixture of kinds during the process. The number of these seed farms in 1911 was 42, and it is estimated that upwards of 250,000 lbs. was distributed through their agency. The number of farms has since been increased to 120, and it is expected that 600,000 lbs. of seed will be distributed when the present crop is picked. The Akola farm, which supplies the private seed farms, was inspected by Mr. Arno Schmidt, Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, in 1911, who stated:

"The whole farm, in consequence of its sound management, does not only act as a nucleus for the other seed farms and as a demonstration to the many farmers who visit it, but it also realises a very handsome profit. I cannot recommend the farm too highly as an example well worth emulation in other Provinces; it certainly is the best and most effective seed and demonstration farm I have seen in India."

A similar system of seed distribution of the Akola cottons is being developed in the Nimar District of the Central Provinces by Mr. Evans.

It will be seen that the methods of cotton seed distribution in the Central Provinces and Madras have one important difference. In Madras,

the seed is grown for the Agricultural Department under contract and comes back every year to stock the village depôts. In the Central Provinces, private seed farms are supplied from the Government farm and the work of seed distribution is in the hands of the seed growers themselves. It will be interesting to watch the progress of these two systems and to see which is the more effective in bringing about a permanent improvement in the cotton crop.

In the Bombay Presidency, the distribution of improved cotton seed has not made the same progress as in the case of Madras and the Central Provinces. In Guzerat, the improved cottons obtained by the Agricultural Department are not markedly better than those already grown by the cultivators. Some types however have been obtained which the trade is prepared to purchase at a premium of five per cent. over the prevailing bazar rate for local Broach cotton. The distribution of these improved cottons is being arranged for through the Bombay Cotton Trade who have formed a syndicate to buy up at a premium of 5 per cent. all the seed cotton which is produced by cultivators in the Surat District from seed supplied by the Agricultural Department. The syndicate also provides facilities for the separate ginning of this seed cotton under departmental supervision and the return of the seed to the Agricultural Department for redistribution. The seed is then given out to groups of villages where only this kind is grown and the harvest is taken over by the ginneries as described above. In the present season arrangements have been made to distribute sufficient seed to sow 10,000 acres.

In Dharwar, Broach cotton has been found to do well, but after a time the seed deteriorates, so that the best arrangement has been found to be to import fresh seed from Guzerat each season for the cultivators. This can be done at a price of Rs. 2 per maund compared with Rs. 1-4 for local *Kumpta* cotton seed.

In Sind, under present irrigation conditions, the efforts of Mr. Henderson, the Deputy Director of Agriculture, in improving the local cotton are confined to the growth on a large scale of American Upland. Arrangements have been made to sow 4,000 acres of this cotton and a Bombay syndicate has been formed to finance the growth, to erect gins and to sell the product as graded American Upland. This cotton is worth 25 per cent. more than the local staples and will be grown largely in a part of Sind in which cotton is not at present cultivated. There will, in these tracts, be no possibility of admixture or crossing with local kinds.

In the United Provinces, progress has been made in cotton seed distribution by Dr. Parr, from the Aligarh farm. From the local cotton

a white flowered type has been isolated which is characterised by a high yield of *kapas* and a ginning percentage of 40 per cent. The staple however is somewhat shorter and coarser than the local yellow flowered kind. This disadvantage in character of lint is however more than made up for by the increased yield and high ginning percentage. About two thousand acres of the white flowered cotton are being sown this year and the crop will be purchased by Government so that the seed will be available to sow 30,000 acres next year. A great demand for seed has arisen and there is every prospect that this cotton will be established in the neighbourhood of Aligarh.

A beginning has also been made at Cawnpore by Mr. Burt where a new farm has been started for the supply of cotton seed. The white flowered cotton from the Aligarh farm is being grown for distribution to cultivators. About 1,500 acres of land round Cawnpore have also been sown with Dharwar American cotton, which will be bought by a Cawnpore mill at a premium.

During the past year the report of Mr. Arno Schmidt, Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, on his visit to the cotton growing tracts of India, in December 1911 and January 1912, has drawn pointed attention to the work on the distribution of the seed of improved cottons in India. The report, considering the short period of the Secretary's visit and the many-sided aspects of the subject dealt with, is a very valuable one and is certain to lead to good results. The Secretary was particularly impressed by the seed distribution arrangements at Akola and recommended that "The system adopted by the Central Provinces of having two or more 'nucleus' seed farms owned by Government and a large number of smaller seed farms owned by intelligent cultivators, spread all over the Province, is to my mind the most essential means for improving the staple and of increasing the yield. Such seed farms are especially required in the Bombay Presidency, in the Punjab and the United Provinces." In considering this recommendation it must be borne in mind that the chief cotton distributed from Akola is a short stapled heavy yielding kind with a high ginning percentage which has been found suitable for the tract in question. *The improvement aimed at is one of yield and no question of quality is involved.* Consequently admixture of this cotton with other kinds and a certain amount of natural crossing are not so important as in the case of the distribution of selected Karanganni in Tinnevelly, of Cambodia in South Madras or of improved Broach in Guzerat. In all these latter quality of the fibre is the main consideration and mixing at ginneries and natural crossing are far more

important. The object at Akola is not the same as in the other tracts referred to and a system of seed distribution that suits the short staple cotton of the Central Provinces may not be the best in Madras. It may be much the best policy for Madras in the long run to control the seed distribution till the whole of the existing cottons of particular tracts are replaced by one improved kind. If the seed of improved long staple kinds is grown by private seed farms it is possible that adulteration will be practised and the degeneration of the staple will only be a question of time—a state of things which apparently has already begun in Madras with Cambodia. Another matter in connection with seed distribution mentioned by Mr. Arno Schmidt refers to the establishment in India by the English spinners of agencies for the buying, ginning and export of long stapled cotton. This is considered to be unnecessary as it is stated that the same result can be more easily achieved by co-operation with the Indian mill-owners. It is pointed out that long stapled cotton grown in India need not necessarily be purchased by Lancashire. Any of this cotton sold will naturally go to the highest bidder and whether it is consumed by Lancashire, India, Japan or the Continent does not matter as a corresponding amount of American cotton will be set free. In the whole report the work done by the Indian Agricultural Department on cotton is dealt with with great fairness and full credit is given for what has already been done. The Committee of the International Federation of Master Cotton Spinners' and Manufacturers' Associations considered Mr. Arno Schmidt's report at a meeting held at Salzburg on May 13th and 14th, 1912, and referred to the work on cotton of the Indian Agricultural Department in their second resolution as follows:—

> "This Committee expresses its high appreciation of the work undertaken by the various Agricultural Departments in India and respectfully urges on the Secretary of State the absolute necessity of strengthening the European staff in every Province if the measures for the extension of cotton cultivation that have been introduced are to have any prospect of success."

**Wheat.** In the case of this crop, in which self-fertilization is the rule, the question of seed distribution does not present the same difficulties as have to be overcome in the case of cotton. It is only in irrigated tracts like the Punjab, where the air is dry, that natural cross-fertilization in wheat is of sufficient importance to be considered in the work of seed distribution. Admixture of kinds in wheat at threshing time can be to a great extent prevented by using a separate threshing floor for each kind or by the use of pucca floors which can be swept clean

between the kinds. Even when admixture takes place the cultures can be started afresh from a single plant and a large quantity of pure seed is very soon obtained. Further, the amount of seed per acre in wheat is relatively large so that the area of the seed farms is not so large as in the case of cotton. The only problem in wheat distribution in India after the best wheats for any tract have been obtained is the question of grades. To accomplish the greatest possible improvement in wheat production in India it is necessary to establish definite grades of wheat of known quality in the various tracts, so that these grades may become well known in the markets of Europe. The position of Canadian wheats on the Home market is largely due to the grades which have been established and which are maintained by the assistance of Government. To establish such grades in India it will be necessary to confine seed distribution in the various tracts to wheats of one or two grades and to replace the existing crop by these grades. Such wheats should be suitable for the export trade and also for local consumption and it will be necessary to operate with a very small number of wheats which would fall into two grades at the most.

In the wheat growing areas of the northern portion of the Central Provinces progress has been made by Mr. Evans in improving the grade of soft white pissi wheat which has been for some years a feature of this tract. The improvement consists in extending the cultivation of selected white pissi and keeping it free from red and other impurities. The work is directed from the Powarkhera farm near Hoshangabad which supplies forty private seed farms in the Northern Circle. These seed farms are grouped round some important market and the growth, threshing and storage of the wheat is supervised by the Agricultural Department. One essential condition for each private seed farm is the provision of a separate threshing floor for this wheat. The Government has the first refusal of any seed not required by the grower and it is proposed to re-stock all the seed farms every fourth year from Powarkhera. In this way it is expected that a grade of improved white wheat, practically free from admixture, will be established in this tract to the benefit both of the cultivator and the trade.

A beginning has been made in the distribution of the strong wheats of high yielding power produced at Pusa. These were tried last year on a large number of estates in Bihar and about 1,500 acres were grown. The results were so satisfactory that seed farms, 500 acres in extent, under the supervision of the Imperial Economic Botanist have been started on three estates. The seed is being grown by the Planters concerned under directions from Pusa and the farms will be re-stocked from

time to time from Pusa. As soon as sufficient seed is available for the market a grade of superior strong white wheat will be offered to the trade. In the various Provinces where Pusa wheats have been tried with success the distribution of seed will naturally be in the hands of the Provincial officers concerned. Thus in the United Provinces Mr. Leake is growing large quantities of seed at Cawnpore and Aligarh and in the Central Provinces Mr. Clouston is developing the work from Tharsa and Raipur. The investigations at Pusa will be confined to the production of new kinds and to the growth of sufficient seed for re-stocking periodically the various seed farms in Bihar and other Provinces.

Besides wheat and cotton a considerable amount of seed of some of the other cultivated crops of India has been distributed from the various Government farms, but the quantity has not been beyond the means of these farms and in no case has it been necessary to establish special seed farms as in the case of cotton and wheat.

## II. INVESTIGATIONS.

**Sugarcane.** The present position of the Indian sugar industry has been the subject of considerable discussion during the year. The steady increase in the yearly imports of foreign white sugar into India, combined with its low price, has resulted in the decline of the area under cane and in the decrease of the number of sugar mills and refineries in the most important sugar tracts of India. In the quinquennial period ending 1889, the import of foreign white sugar was 79,638 tons while at present it is over 700,000 tons per annum. Attention was called to the subject at the meeting of the Imperial Legislative Council in Calcutta in March 1911, and at the recent Agricultural Conference held at Allahabad. In consequence, the present position of the Indian sugarcane industry and the means by which it can be improved were exhaustively discussed, at the instance of the Government of India, at the recent meeting of the Board of Agriculture in India, and a detailed programme of future work was prepared.

From the botanical point of view the main recommendation of the Board of Agriculture related to the establishment of an acclimatisation and cane-breeding station in Madras which it was suggested, should be placed under an Imperial officer. This proposal was subsequently adopted by the Government of India and sanctioned by the Secretary of State and a large grant for the purpose has been placed at the disposal of the Government of Madras under whose direction the station has been placed. It is proposed to found the sugarcane breeding station at Coim-

batore, and, although final orders have not as yet been issued, a certain amount of preparatory work has been accomplished by Dr. Barber. About 90 kinds of cane have been collected for comparison and these have been somewhat exhaustively studied. The attempt to raise seedling canes in India has been renewed and the reasons for former failures in this respect have been investigated. It has now been discovered that these failures are almost entirely due to the fact that most of the indigenous canes, as far as examined, do not form fully developed stamens, the rest of the flower being apparently normal. One native cane and two introduced ones have, however, been thus far found to contain a number of open anthers in the flowers and, acting upon this clue, a considerable number of cane seedlings have been already produced. It is anticipated that there will be no further difficulty in this matter, once the sugar station is sanctioned. As might have been anticipated, these seedlings vary considerably among themselves even when of the same parentage, and the next step in the enquiry will be the far more difficult work of selection and the discovery of criteria by which unprofitable forms may be eliminated before too much time is spent upon their study. A more detailed description of the work thus far done has been prepared for the *Agricultural Journal of India*. The lines on which it is proposed to conduct the station are as follows:—

(1) The collection of all canes growing in India, their comparison and classification, (2) a study and comparison of the cane-growing tracts of India, with special reference to climatic conditions and agricultural practices, (3) such study of the anatomy and physiology of the sugarcane plant as circumstances may demand, (4) the introduction of as many canes from other countries as possible, with special reference to the requirements of Northern India, (5) the raising of cane seedlings and the selection of such as appear to be of value in the same tract, (6) the study of the flowers, growth and life-history of the wild Saccharums of India.

Progress continues to be made in Madras in the successful introduction of new canes. In the South Arcot District the Red Mauritius variety continues to make rapid progress. Here, as in the Godavari delta, the local canes have disappeared, no less than 96·2 per cent. of the area under cane in South Arcot last year being Red Mauritius. The Director of Agriculture of Madras writes: "From experience gained in South Arcot it may now be stated confidently that, with the superior canes now available, and good cultivation and management, India can produce

refined sugar at a price capable of competing with Java sugar. Large areas of suitable land with an ample supply of subsoil water being available, we may expect to see South Arcot become the leading centre of the sugar-industry in Southern India." As an example of the spread of Red Mauritius cane among the Madras cultivators the following figures showing the progress in the vicinity of Nellikuppam speak for themselves:—

| | | | | Acres. |
|---|---|---|---|---|
| 1907 | (Red Mauritius canes from Melrosapuram) | | | ... |
| 1908 | Do. | do. | do. | 145 |
| 1909 | Do. | do. | do. | 409 |
| 1910 | Do. | do. | do. | 876 |
| 1911 | Do. | do. | do. | 2,250 |

In the United Provinces the *Saretha* variety (a thin cane), which has done best at Aligarh, is being distributed to the cultivators and around the same centre some of the thick Mauritius canes are replacing the local varieties of thick cane grown for chewing purposes.

In selecting new canes for tracts like the alluvium of the Indo-Gangetic plain, where the monsoon is followed by cold weather of considerable intensity, the recent work of Mr. Somers Taylor at Sabour is of great interest and value. This observer, in a recent paper published in the *Agricultural Journal of India*, has drawn attention to the consequences of the great difference in growth conditions between tropical islands like the West Indies and Java and sub-tropical regions like the plains of India. In the former, both growth and ripening are practically continuous and there is, as it were, no hurry for the canes to ripen. In tracts like Bihar however the cold season cuts short growth and in many cases interferes with the ripening process. What is wanted under such conditions are canes which can ripen properly in the available growth period and for this rapidly maturing varieties are essential. These investigations also show the need of chemical control in variety trials of canes in India and the discovery of some easy method of determining when the canes are at their best.

At Sabour, Mr. Woodhouse has made some interesting observations on the flowering of the sugarcane. While many varieties flowered in 1911, in only one case were the anthers observed to dehisce and even here no seedlings were observed.

**Wheat.** Progress continues to be made in wheat investigations in India and during the year several papers have been written which are now in course of publication.

In the United Provinces, Mr. Leake has summed up the results of his experiments with this crop at Cawnpore in a paper now in the press. At this station it has been found that under canal irrigation high grain quality is easily produced provided the preliminary cultivation is thorough and care is taken in the regulation of the water supply. Further, crops of as much as 2,500 lbs. to the acre have been grown with much less water than is used by the cultivators. These results are of the greatest value as they show that high quality in wheat is possible in the alluvium with canal irrigation and that a considerable saving of canal water can be made in the growth of this crop.

An important stage has been reached in the experiments on the influence of environment on the quality of wheat and the results, which include the crop of 1911, have been submitted for publication. In these experiments wheats of widely different quality, including strong free milling wheats, have been grown at many stations in the plains and also on the black soils of Peninsular India. The circumstances under which the wheats have been grown have differed widely and the range of conditions have been as great as would occur if the same wheat were grown by the best and the worst cultivators. It has been found that the weak wheats have always remained weak but their milling and baking qualities have been improved to some extent by cultivation. Strong wheats with good milling qualities have, on the other hand, been found to retain their strength and free milling nature both under canal irrigation in the alluvium and also as a dry crop on the black soils of Peninsular India. Even when grown after rice the same year and with inadequate cultivation the strongest of the wheats grown always showed its superiority in the milling and baking tests. These results are important in the improvement of the wheat crop in India as they indicate vast scope for progress in the future even after the highest possible yield has been realised. Where the limit of yield has been reached there will still remain the question of quality. These experiments also throw light on the relations between yield and quality in wheat. It was found in the case of any particular wheat that the conditions which produce the highest yield are those which also produce the best quality. Further in the same wheat high yield and high quality can be combined. A cultivator therefore, who wishes to obtain the greatest financial return for his labour, should grow to perfection a wheat which combines high yield and good grain qualities. When this is accomplished Indian wheats will be second to none in the markets of the world. During the investigations of the relation between yield and quality two adverse factors in wheat production in the alluvium were investigated—water-

logging during the monsoon and late cultivation. Both influenced the yield and to some extent the quality. Waterlogging for a month only reduced the yield about fifty per cent. while late cultivation was responsible for a diminution of about one-third the total crop. Another interesting fact arose out of these experiments, namely, the change of consistency in the same wheat when grown in different places and under different conditions. In general the consistency of the wheats grown varied greatly with environment. A few hard wheats however showed a tendency to remain hard while several soft wheats always remained soft and never hardened. It is possible that these constant soft wheats are always characterised by poor milling qualities, a point which is now being investigated.

In the wheat breeding experiments at Pusa, an account of which is now being published, several interesting results have been obtained. The wheats employed in this work, which was stated in 1906, have been throughout pure line cultures, that is to say, the parents were originally grown from a single ear. In this way only is there any prospect of obtaining results of permanent value in hybridization work. In addition the number of plants used in the second generation has often been over one thousand in number. The results confirm and extend those obtained at Svalöf and show that such apparently simple characters as colour of grain, presence of awns, felted chaff and resistance to rust are often exceedingly complex and involve the existence of several factors. The number of these inheritable factors in wheat is considerable and this fact explains the very large numbers of different types met with in cultivation. In breeding new forms it is essential that the gametic constitution of the parents should be known and the number of factors determined. Indeed the subject is so complex and the number of plants necessary is so large that it is desirable to restrict all hybridization work in the Agricultural Department to a few centres in India where the requisite facilities and supervision can be provided. It is doubtful whether any useful results will ever be obtained unless these conditions are fulfilled.

During the past year the wheats produced at Pusa and the methods of cultivation for this crop worked out at this station have been tried at many centres in India. The detailed results of this work have already been brought to the notice of the Government of India in the writer's last annual report so they need not be repeated here. It is sufficient to state that the results obtained in Bihar, the United Provinces, the Punjab and the Central Provinces have been most satisfactory and that the demand for seed which arose from these trials could not be met,

**Fruit.** Considerable attention is now being paid to the improvement of Indian fruit—an important matter in a country like India with such a large vegetarian population. In Bombay, Mr. Burns has devoted a considerable amount of attention to various questions relating to fruit growing at Ganeshkhind near Poona and also at Bassein in the Konkan. The methods of pollination of the mango are being investigated and it appears that the flowers set under bag without the intervention of insects. In the case of the papaya the work done so far indicates that parthenogenesis occurs in this crop. Several other questions relating to fruit are being taken up which promise to yield interesting results.

At Saharanpur, Mr. Hartless has devoted attention to several questions relating to the mango crop. The well thrown deleterious effect of damp and rainy weather at flowering time on the setting of the fruit is said to be due to the influence of humidity on the pollen. Hence early and late flowering kinds should always be grown so as to increase the chances of successful pollination. In connection with the work on polyembryony in mangoes, observations on this subject have also been made at Saharanpur. So far as the observations go the Indian grafted mangoes show no polyembryony although this condition has been found in seedlings.

In the Punjab, Mr. Milne has devoted attention to the culture of dates which is being started by the Provincial Agricultural Department from Multan and Muzaffargarh as centres. A detailed paper giving information on the cultivation and the conditions requisite for success has been issued.

At Quetta, a new fruit experiment station, 25 acres in extent, has been started during the year and considerable progress has been made in laying this out and in providing buildings and an artesian water supply. During this preliminary work attention has been paid to the best methods of packing fruit for long journeys under Indian conditions. Returnable packages have been found impracticable for long distances on account of the cost of the return journey and of the frequent overcharges made by the Railway Company. Loss by thefts in transit are common, but it should be possible to put an end to these practices if the staff concerned with these packages are made jointly responsible. Cheap light non-returnable packages have been found most useful and a large number of these were put on the market at Quetta during the present summer. Over one thousand peach boxes have been sold, many of which have been purchased by the Indian dealers. A bulletin is in preparation on this subject as it is felt that great improvements in the transport of

fruit are immediately possible in India without waiting for cold storage vans.

**Cotton.** Attention is being paid to the inheritance of flower colour in cotton at the Dharwar and Surat farms in the Bombay Presidency. An account of this work is to be found in the recent reports issued from these stations. At Cawnpore, Mr. Leake has continued his important investigations into the inheritance of characters in cotton and considerable progress has been made in the isolation of new kinds. A detailed account of these researches was given in the last report. Recently another paper has been published at this centre dealing with the characters and classification of the cottons obtained from Persia and Eastern Asia. A beginning has also been made in cotton breeding work at Coimbatore and the Madras Government proposes to appoint an Assistant Economic Botanist who will be employed, to a large extent, with the improvement of this crop.

**Miscellaneous.** Messrs. Finlow and Burkill have published an account of their investigations on the inheritance of the red colour in the common jute plant, *Corchorus capsularis* L., and state that self-fertilization is the rule in this species in India. Under the most favourable conditions for crossing the amount is said not to exceed two per cent., while in ordinary circumstances it may be much less and may not exceed 0·2 per cent. It seems probable that the colour factors in jute are not simple, as the authors suppose, but complex and the published figures point to the existence of two red factors at least. At Coimbatore, Dr. Barber has paid some attention to the types of *Hibiscus cannabinus* and the fibre of the various varieties has been compared. An account of the last year's working of the flax experiment at Dooriah in Bihar has been published by Mr. Vanderkerkhove in Pusa Bulletin No. 30. A profit of Rs. 63 per acre was obtained, but in spite of this satisfactory result planters are not inclined to take up the growth and manufacture of the fibre. Mr. Coventry, in an introduction to this paper, states that the disinclination of the planters to embark in this industry "seems chiefly due to the large amount of expert knowledge and capital required on the industrial side which are not easily commanded by the grower and there is, therefore, a difficulty in combining the two undertakings." In future, the growth of the flax and the factory aspects will be kept separate. Dr. Barber has published an interesting account of the sensitive plant (*Mimosa pudica*) in Coorg, where it is regarded as a dangerous weed. The methods of eradication are discussed and an account of various experiments for destroying the weed, including spraying with sodium arsenite, are given. A new coffee experiment station for the

investigations are already in progress. An account of the Italian millet (*Setaria italica*) in Bengal, in which the pollination mechanism and the occurrence of natural crossing have been worked out, has been published by Mr. Woodhouse and Babu A. C. Ghosh.

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## PART II.—FOREST BOTANY.

BY

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**Œcology of sal.**—This work was continued on the lines indicated in last report, publication having been deferred in order to include the results of observations made in the Dehra Dun sál forests by the Botanist during the year and the soil analyses and water determinations carried out by the Forest Chemist in connection therewith. The results will shortly be sent to press, but it may be mentioned that the work done shows that sál seedlings die when the moisture-content of the soil in contact with their roots falls below 1 per cent. and 9 per cent. respectively in sand and heavy loam. It was pointed out in a previous report that the species of grass dominant in a particular locality is frequently an accurate indicator of the prevailing conditions of soil and moisture, and that where *Saccharum Munja* is dominant the locality is suitable for dry-miscellaneous-forest species, whereas the dominance of *Saccharum Narenga* indicates soil and moisture conditions suitable to sál. In connection with this it is interesting to note that a series of soil samples selected during the year in local grass-lands of these two species in June, (*i.e.*, in the critical period before the break of the rains), showed a moisture content at the depth of 1′ 6″ (which is the average depth reached by the roots of sál seedlings in their first year) of 0·8 to 1·6 per cent. in the case of the former species and 16 to 19 per cent. in case of the latter. This clearly indicates the *primâ facie* unsuitability of grasslands of *S. Munja* for the growth of sál. The work done up to date will be shortly published and an extended series of experiments has been arranged for the further study of soil-moisture and light and the effect of these factors on the healthy development of sál.

**Forest Grasses.**—The study of Forest Grasses has been continued on the following lines:—

(1) The publication of descriptions and illustrations of the species likely to be most valuable, on account of their known

economic value, on account of their dominance over large areas, or because they occur constantly in admixture with valuable species and are likely to be confused with them. The first object of such publication is to focus attention on the more valuable species and to facilitate their identification.

(2) The determination of the best treatment to apply to forest grasslands with the object of realising, on the one hand, the best economic return from the grasses and, on the other hand, of facilitating the afforestation, with valuable trees, of those grasslands not required for the production of grass.

(3) The determination, in collaboration with other specialists, of the economic value of the species dealt with for fodder, paper-pulp and other purposes.

During the year descriptions and illustrations of the following species were published:—*Saccharum spontaneum* Linn., *S. Munja* Roxb., *S. Narenga* Wall., *Erianthus Ravennæ* Beauv., *Imperata arundinacea* Cyrill., *Triraphis madagascariensis* Hook. f., *Aristida cyanantha* Steud., *Andropogon monticola* Schult. The principal taxonomic and œcological results included in this publication have been briefly noted in the reports of previous years. The study of the following species on similar lines to the above was commenced during the year:—*Anthistiria gigantea* Cav., *Eragrostis cynosuroides* Beauv., *Phragmites Karka* Trin., *Arundo Donax* Linn., *Ischæmum angustifolium* Hack. and *Vetiveria zizanioides* Stapf.

**Development of culms.**—The importance of studying the life-history and development of the various species is shown by the fact that in some of the larger species which are likely to be most valuable for paper-pulp, *e.g.*, *Saccharum Munja* Roxb., the culms, instead of being annual, require 2 years for their full develcpment and consequently such species must be worked on a rotation and not cut annually, if a full and regular yield is required. In addition to this, the liability of a species to damage, *e.g.*, by fire, depends on the period required for the development of the culms and on the condition of growth at the season when fires usually occur. It is obviously of importance, therefore, to discover a method by which the period required for development can be readily ascertained by an inspection of the culm and it has been found that there is a definite relation between the number of nodes and leaves produced by the culm and the number of months constituting its period of growth,

although this varies in different species. During the year a detailed study in this connection was made of the development of the culms of wheat (*Triticum sativum*) which is a convenient type of an annual grass and the results will be published next year. Notes also on this point have been given regarding the species mentioned above, of which descriptions have been published during the year and it is hoped that a generalisation on this point will soon be possible, covering (1) annuals, (2) perennials with annual culms with one period of growth, (3) perennials with annual culms with two periods of growth and (4) perennials with biennial culms. It may be noted incidentally that this point is not only of importance in the management of grasslands, but has a direct bearing on the question of selecting suitable types of an agricultural cereal, such as wheat, for cultivation in tracts with a particular climate and length of growing season.

**Distribution of species and possible yield.**—From an economic point of view it is essential to obtain accurate information regarding the distribution of the chief dominant forest grasses and of the approximate area occupied by them, seeing that, apart from other important points, the yield and possibility of establishing an industry, *e.g.*, for the manufacture of paper-pulp, depends on this. With the object of facilitating the collection of such information the Botanist has identified a number of grasses, which have been sent in by local forest officers, amounting to 150 specimens during the year. A direct result of this work is that local officers in the United Provinces are now preparing maps showing, in each Division, the approximate area occupied by the chief dominant grasses. The map for the Ramnagar Division has already been received and it is hoped that others will shortly follow and that this work will be taken up also in other Provinces. The information supplied by these maps will obviously be of the greatest value in such questions as the determination of the best sites for paper-pulp factories, or for extensive fodder operations, in addition to indicating the chief types of grassland which require separate study by the Botanist.

**Value for paper-pulp.**—With the object of determining the value of the chief dominant species in North India for paper-pulp, specimens of 22 carefully identified species were submitted to Mr. Raitt during the year for analysis. Those species were especially selected which promised to be of most value on account of their occurring dominant over large areas or constantly in mixture with other valuable species. Mr. Raitt was unfortunately unable to do more

than make a preliminary examination of this material based on simple tests. This examination, however, indicated that 14 of the species, including the very common and widespread *Kans* (*Saccharum spontaneum*), were likely to yield a high-grade pulp and to be of considerable value for the manufacture of high-class paper. Towards the close of the year, however, Mr. Raitt was again able to take up this work and it was then decided to prepare a detailed analysis and report dealing with 10 principal species and a less detailed report regarding 8 subsidiary species. Special attention is being paid to the point as to whether the value of the former is likely to be greatly diminished by an admixture of the latter, the principal and subsidiary species often growing together in nature. It is hoped that this work will be complete by October next.

**Burmese Kaing grass.**—An interesting point taken up during the year was the identification of the so-called Burmese *Kaing* grass. Specimens sent under this name had been previously examined by Mr. Raitt, who reported that it would form an excellent material for the manufacture of paper-pulp and its correct identification was therefore of importance. Through the kindness of Mr. J. H. Lace, Chief Conservator of Forests, Burma, numerous specimens of *Kaing* were sent to the Forest Botanist during the year which proved that at least 15 species, belonging to the genera *Saccharum*, *Andropogon*, *Anthistiria*, *Arundo*, *Phragmites*, *Rottbœllia*, *Coix*, *Triraphis*, *Thysanolæna* and *Polytoca*, passed under the name of *Kaing*. It is therefore clear that this is merely a general term given in Burma to all large grasses growing in savannahs and swamps, a descriptive epithet often being attached, such as *Paung Kaing*, *Sit Kaing* and so on.

**Value for Fodder.**—Various experts in India, Europe and America were addressed during the year as to the possibility of devising a system of analysis which could be trusted to indicate the relative fodder-value of our forest grasses. Unfortunately no such method is at present known and the only satisfactory procedure appears to consist in feeding experiments which it is hoped may perhaps be arranged for in co-operation with Pusa.

**Miscellaneous Notes.**—Miscellaneous notes of interest in connection with the grass specimens sent in by Forest Officers to the Botanist during the year are:—

(*a*) The discovery of *Erianthus elephantinus* Hook. f. by Mr. P. H. Clutterbuck in the Haldwani Division, United Provinces. This species has hitherto only been known with certainty from Assam.

(*b*) The discovery of an *Arundinella* (vern. *tadhodia*) by Mr. T. Carr, Divisional Forest Officer, Haldwani, which, although allied to the ordinary Indian form of *A. brasiliensis* Raddi (vern. *phurkia*), differs from it considerably and is possibly a distinct species. Further specimens have been asked for with the object of cultivating the grass at Dehra.

(*c*) Aromatic specimens of *Andropogon intermedius* Br. sent by Mr. J. Whitehead, Divisional Forest Officer, Gorakhpur, United Provinces, showed that there is practically no character to separate this species from *A. odoratus* Lisboa, except only that glume I of the latter is pubescent. It is probable that the latter is merely a variety of the former.

(*d*) The discovery of *Cymbopogon Schœnanthus* Spreng. in Goalpara, Assam, by Mr. Atulananda Dass, Extra Assistant Conservator of Forests. This species has hitherto not been reported east of the Punjab.

(*e*) The discovery by Mr. Witt, Deputy Conservator of Forests, Central Provinces, of an *Iseilema* allied to *I. laxum* Hack. but possibly distinct. The grass has been sown at Dehra and will be described in detail if it proves sufficiently distinct.

**Systematic work. Xylia.**—Through the kindness of local forest officers, a number of specimens of *Xylia* were received during the year from Burma and India. A preliminary examination of this material revealed the remarkable fact that, whereas all the specimens from Burma (Katha, Pyinmana, Toungoo, Zigon, Henzada and Ataran Divisions) showed no glands upon the anthers, all the specimens from India (from North Thana and North Kanara in Bombay, from South Malabar in Madras and from Balaghat and Bhandara in the Central Provinces showed a large and perfectly distinct stipitate gland on the anthers. It appears probable, therefore, that the Indian tree will have to be distinguished as *Xylia xylocarpa* Roxb. while the Burmese pyinkado will stand as *Xylia dolabriformis* Benth. Further study, however, is necessary to settle this and other points. A paper detailing the results obtained to date and indicating what specimens are still required for the adequate description of the Indian and Burmese forms of this genus was contributed to the *Indian Forester* at the close of the year.

**Grewia.**—The study of this genus was continued but, not being of first-class importance, had frequently to give way to more important work during the year. It is hoped, however, that publication will be

completed next year. There is probably only one other known genus (*viz.*, *Eucalyptus*) in which similar complications are met with on account of the occurrence of adventitious shoots and in *Grewia* the complications are increased by the fact that such twigs commonly bear, not only leaves, but also flowers and fruit which often differ widely from those of normal twigs. Consequently it is impossible to work on sound lines unless it is known whether the material dealt with is adventitious or not. The patient collection and study of suitable material in this case, therefore, requires much time and unusual labour.

**Identification and local forest floras.**—The collection of material for the study of the genera *Saccharum Cinnamomum* and *Anogeissus* was continued as far as possible. Seeds of the various forms of Babul, *Acacia arabica*, were obtained and sown at Dehra for the purpose of testing their constancy. Owing to the fact that local forest officers are frequently ignorant of the names of the species which occur in their forests, it is at present very difficult, or impossible, to obtain accurate information regarding the distribution of species of economic importance or to calculate the yield available in different localities of the economic products yielded by them. The creation and extension of industries depending on these products is consequently delayed and hampered. The preparation of local Floras and Lists which would enable any one of average ability to quickly identify the important species found in his forests is therefore a work of considerable economic importance. Owing to the necessity of encouraging this work and to the fact that the Botanical Library and Herbarium at Dehra Dun have now become fairly efficient, it was decided during the year that the Botanist ought to undertake the identification of specimens for Forest Officers, as a part of his regular duties. Owing to the fact that the Botanist has no Assistant and is obliged to do this work himself, it is clear that it can be carried out only on a small scale at present, as otherwise the progress of research work would be seriously hampered. During the year under report, however, the Botanist identified 246 specimens, whereas in previous years the total number of specimens identified has not exceeded 50.

**New species.**—Incidentally this work has resulted in the discovery of a new species of *Albizzia* from the Tinnevelly district of Madras. This was found by Mr. H. A. Latham, Deputy Conservator of Forests, and a full description of the same under the name of *Albizzia Lathamii* was sent to press during the year. A *Terminalia* new to Burma has been received from Tavoy, a description of which will shortly be published,

and a *Litsæa* from the Tista Division of Bengal which will also probably prove to be new.

**Exotics.**—A considerable amount of time and money has been spent in the past by Forest Officers in India on the cultivation of exotics. In order to realise the maximum benefit from the work which has been done, it is proposed to systematically collect and publish all the information available regarding those exotics which distinctly promise to be of forest importance in India, with notes on the conditions under which they have been found to thrive and their economic uses. A paper on this subject dealing with *Prosopis juliflora* DC. was sent to press during the year. Future publications will deal with *Eucalyptus* species and others. It is also hoped that, in future, it will be possible to arrange for more precise information, than has usually been available in the past, regarding valuable exotics and the conditions most likely to suit them, from foreign correspondents to whom seeds of our indigenous species are supplied.

**Tree diseases. Spike-disease of Sandal. Trametes Pini.**—Arrangements were made at the close of the year for the collection of all the available literature and information regarding the spike-disease of Sandal, the study of which will be commenced by the Botanist in Coorg next year. The results of the preliminary investigation regarding the attack of *Trametes Pini* on *Pinus excelsa* in the Punjab will it is hoped be issued early next year.

6. In addition to the specimens noticed in the above report many were collected as usual by local officers and sent to the Imperial Mycologist, Pusa, Calcutta Botanical Gardens, Reporter on Economic Products to Government of India, and others. The formation of a local forest herbarium was commenced by the Chief Conservator of Forests, Burma, during the year and collections for the local forest herbarium, Sind Circle, were continued. Mr. A. Rodger continued his work on the preparation of a list of species for the Ruby Mines Division. Mr. D. O. Witt published his illustrated list of the grasses of the Berar Circle, Mr. W. A. Talbot published the second volume of his *Forest Flora of Bombay* and Mr. Rama Rao an account of the host plants of the Sandal tree. Further details are given under the Botanical Survey and Mycology sections of the report.

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KOGEKAR, V. K. . Some of the commonly grown *rabi* jowars. (*Poona Agr. College Magazine, iii, 254, 1912.*)

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# BOTANY.

## III.—MYCOLOGY.

BY

E. J. BUTLER, M.B., F.L.S.,

*Imperial Mycologist.*

### I.—Plant Pathology.

The work of the Mycological Section at Pusa, which was completed during the year, includes investigations on sugarcane diseases, *Rhizoctonia* and *Phytophthora Colocasiæ*.

The chief diseases of sugarcane investigated were red-rot and an undescribed disease caused by a species of *Cephalosporium*, which presents many points of resemblance to red-rot and is frequently confused with it. The actual channels by which the parasites gain entrance to the cane have been determined by a large series of inoculation experiments. It is hoped that the result of the work, an account of which is being prepared for publication, will be to improve the methods by which serious injury from these diseases may be prevented.

Mr. Shaw, Supernumerary Mycologist, has in the press an account of his researches during the past two years into the morphology and parasitism of *Rhizoctonia*, a soil-dwelling parasite with a wide range of victims. Jute, cotton, ground-nut, cowpea, potato and sesame are amongst the plants attacked. Two species are distinguished, *R. Solani* Kühn, of which the perfect fruiting stage is not yet certainly known, and a species with larger sclerotia, of which the fruiting stage is the Basidiomycete, *Corticium vagum* B. & C. For the last, the old name *R. violacea* Tul., ordinarily used to cover both forms, is proposed to be retained. The beginnings of the formation of specialised races on individual hosts can be observed in *R. Solani*, as the race on jute cannot infect cotton, ground-nut or cowpea, while the forms on these last three hosts can pass freely from one to another. No cereal crop has, so far, proved susceptible to the attacks of these parasites and in a proper attention to rotation probably lies the best means of lessening their ravages.

A disease of the country vegetable, *Colocasia antiquorum*, caused by *Phytophthora Colocasiæ* Rac., has been under study by the writer for some time past. The fungus was obtained in pure culture last year and this has permitted of rapid completion of the investigation, the

results of which will be published shortly. The disease resembles in many respects the well-known potato blight caused by *Phytophthora infestans*, especially in persisting from year to year in the tubers and in only forming a true sexual stage in artificial culture. A second species of *Phytophthora*, on castor, is being studied by Mr. J. F. Dastur, First Assistant, and these two researches have added considerably to our knowledge of the genus.

Mr. Burns has published the concluding account of his three years' experiments in the treatment of grape-vine mildew (*Oidium*) in the Bombay Presidency. The results are considered to demonstrate conclusively the usefulness of the treatment. The spray used was Bordeaux mixture of the 6-4-50 formula (6 lbs. copper sulphate, 4 lbs. freshly burnt quicklime and 50 gallons water) to which was added soft soap at the rate of 5 lbs. The latter was intended to make the spray effective against insects and to increase its adhesiveness. Five sprayings are recommended, one about the middle of May, a second about the middle of August, a third about the middle of October, a fourth about the beginning of December and a fifth about the beginning of January. The last two should be at half strength of the mixture. The result of the treatment has been to reduce the number of attacked bunches from 100 to 21 per cent. and of attacked fruits per bunch from 22 to 1 per cent. The cost is estimated as Rs. 22 initial (cost of sprayer, etc.) and about Rs. 40 per acre annual (cost of materials).

Mr. Anstead has published a detailed account of the work done in Southern India in checking "pink" disease of Hevea rubber, caused by *Corticium salmonicolor* B. & Br. He recommends cutting out the affected parts, where the disease has already appeared, and painting the trees with Bordeaux mixture in May or June as a preventive. The formula recommended is 4-4-45 and resin is added to aid the mixture to stick to the trees. The cost is about a pie per tree or not more than Rs. 2 per acre. The results have been very encouraging and experiments are being continued to perfect the methods.

The writer described two diseases of wild vines, one of which is also known to attack the cultivated species. Neither of these diseases occurs in Europe, where, if introduced, they might become serious pests. Both are caused by rust fungi of unusual types.

Mr. Ajrekar has submitted for publication a note on the rust of Castor (*Melampsorella Ricini*). This fungus is known only in the uredo stage. None of the varieties of castor ordinarily grown in Bombay is

immune. The disease is severe in the southern part of the Presidency only.

Mr. G. S. Kulkarni has given a preliminary account of the red-rot of sugarcane in Bombay, in a paper in which the characters of the disease are described, the methods of treatment indicated and a number of interesting field observations recorded. He has also, in conjunction with Mr. Ajrekar, commenced experiments with a view to checking the *Koleroga* of betelnut in North Kanara, where it is responsible for damage estimated at nine lakhs of rupees annually. Further work on the prevention of the same disease, in continuation of that reported last year, was carried out by Dr. Coleman, who issued a vernacular leaflet on the subject.

## II.—Systematic Mycology.

Two parts of the descriptive list of Indian fungi, which is being issued by Messrs. H. & P. Sydow in conjunction with the writer, were published during the year. These included the *Ascomycetes* and *Exobasidiaceæ* of the Pusa Herbarium, together with additions to the lists of *Phycomycetes*, rusts and smuts previously published. The total number of additional species recorded was 316, distributed in 108 genera, of which 1 genus and 115 species were new to science. A large proportion of the remainder consisted of species new for the Indian flora. Of the new species the majority (72) were *Ascomycetes*, a group which has received little attention in India, 26 were rusts, 11 smuts, 2 *Phycomycetes* and 4 *Exobasidia*.

The writer described a remarkable aquatic fungus found at Pusa and Poona, assigning to it a position in the family *Leptomitaceæ*. It is an aberrant member of the family, inasmuch as it has a completely segmented thallus. Reasons are given for considering the *Leptomitaceæ* to be a more primitive group than is usually admitted, and for holding them to be derived, through forms resembling *Monoblepharis*, from the *Siphoneæ* amongst the green Algæ.

Mr. Ajrekar has worked out the life-history of *Cystopsora Oleæ* Butl. This rust consists of æcidial and teleuto stages only, the uredo being omitted. The whole life-cycle is passed on the one host, *Olea dioica*.

Mr. Kulkarni has discovered the conidial stage of the *Sclerospora* which is parasitic on jowar and considers that it presents sufficient differences from this stage of *Sclerospora graminicola* to warrant its separation as a distinct species,

*List of Publications.*


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# BOTANY.

## IV.—AGRICULTURAL BACTERIOLOGY.

BY

C. M. HUTCHINSON, B.A.,

*Imperial Agricultural Bacteriologist.*

**Soil Bacteriology.**—The work of the Bacteriological Section at Pusa during the year has been mainly directed towards ascertaining what factors determine biologic activity in Indian soils, and to the measurement of the changes resulting therefrom under various conditions. The main problem so far dealt with has been the supply of available nitrogen as provided by the biolysis of such substances as green manures, root residues, and organic manures. No work has been done upon nitrogen assimilation by Legume bacteria or such organisms as Azotobacter, Clostridium, or Rhizobium.

The method of determining the biologic activity of a soil by plate counts has been abandoned in favour of methods depending upon measurement of the physiological activity of the soil organisms. By the use of such methods biological analyses of soils may be carried out which will provide indications as to their relative capabilities for dealing successfully with organic manures. Far more valuable information, however, is also obtained by such analyses. By the use of fairly large portions of soil, it is perfectly feasible to set up and maintain conditions of moisture and æration comparable with those in the field, and to determine in the laboratory for any particular soil under what conditions of water supply, tillage, and addition of lime or manures either natural or artificial the greatest amount of ammonification and nitrification will result.

It has been ascertained by numerous experiments that the rate of formation of carbon dioxide in a soil is directly proportional to the biologic activity of that soil, and that conditions unfavourable to the latter will also adversely influence the former. A simple method of measuring the rate of formation of carbon dioxide in soils under various conditions has been devised and by this means it is possible to determine what moisture content of any particular soil is the optimum for bacterial activity; this has been found to vary from as high as 37 per cent. in one case to as low as 16 per cent. in another. By the same method, the effect of the addition of various manures, organic or mineral, may be observed, and it

has been found possible in this way to prescribe the addition of certain substances, such as lime or superphosphate, to a soil in order to promote the decomposition of green manures, oil cake, or cattle manure buried in it. Similarly by determining the optimum moisture content, recommendations can be made as to variations in field practice which would tend to dry out the soil in one case or to conserve moisture in another; a very large number of observations have been made as to the conditions under which ammonification and nitrification take place in Indian soils. It has been found that important differences exist between the biological changes taking place in the latter and those which have been observed in the soils of Europe; these differences appear to be due to the high average temperatures of Indian soils and their consequently high relative rate of bacterial action. In soil at temperatures between 15° C. and 18° C. the process of ammonification, which is the natural and necessary predecessor of nitrification, takes place at such a rate as to allow the latter to proceed *pari passu;* in many Indian soils, however, it has been found that at the higher temperatures, 25° C. to 30° C. which obtain in them for many months in the year, ammonification may proceed with such rapidity as to produce a concentration of ammonia in the soil water sufficiently high to interfere with nitrification or even to inhibit it altogether. Where large quantities of nitrogenous organic matter are turned into the soil and put under intensive cultivation much nitrogen may be lost in the form of ammonia, and experiments have shewn that biolysis of organic nitrogenous material requires very careful investigation from this point of view.

In particular, it has been found that temperature plays an important part in deciding whether ammonification will proceed at such a rate as to allow of concurrent nitrification; thus organic nitrogenous matter in soil at a temperature of 20—22° C. may be completely nitrified, whereas at 28—30° C. large quantities of nitrogen are lost as ammonia. It is evident that this fact must be taken into account in selecting the time of year for applying organic manures, along with other considerations depending on local meteorological conditions and the optimum moisture content of the soil.

Further experiments have demonstrated another source of loss of nitrate nitrogen. It has been shewn that where intense bacterial action is taking place in soil any nitrates present may be reduced without the occurrence of anærobic conditions; it appears probable that the nitrate is utilized as a source of nitrogen by the bacteria. It was found, for instance, that in Pusa soil the optimum moisture content for nitrification

is 16 per cent., whereas general bacterial action is intense up to 25 per cent. and at the latter figure rapid reversion of nitrate to the proteid form takes place. This would help to explain observations made in field practice both at Pusa and in the Punjab, that excess of soil moisture produces nitrogen starvation of the wheat crop; the importance of biological analysis of irrigated soils by such methods will readily be realized.

A special enquiry has been carried on and is still proceeding, to determine the conditions under which bacterio-toxins are formed in soils and their effect in inhibiting bacterial action. The work of Greig Smith of N. S. Wales on this subject has demonstrated its importance, and experiments at Pusa have fully confirmed his views. Mr. Meggitt, Agricultural Chemist, Eastern Bengal and Assam, has carried out a series of investigations on similar lines, but the enquiry is not sufficiently complete for detailed report.

An investigation as to bacterial action in rice soils was carried out at Coimbatore by the Agricultural Chemist to the Government of Madras. It was found that in puddled soil the anærobic conditions prevailing prevented the formation of nitrate; confirming the conclusions of previous workers that the rice plant obtains its nitrogen in the form of ammonia; further experiments in the field showed that for the same reason the use of nitrate of soda or of potash as a paddy manure, resulted in loss of nitrogen by denitrification.

**Plant Pathology.**—A bacterial disease of tobacco at Rangpur was investigated and found to be due to an infection of *B. Solanacearum*. The strain isolated was found to be also pathogenic to *Solanum Melongena*, Tomato, *Datura*, and Potato. The incidence of the disease at Rangpur and Burirhat was not apparently associated with any insect attack or specially unfavourable soil conditions, and was not heavy enough to cause apprehension as to future spread. The parasitism of the causative organism as isolated from diseased plants in the field was found to be insufficiently strong to attack healthy plants, although by passage through several individuals or by artificial culture on Potato it could be raised to a high degree of virulence. For this reason the practice of leaving the plants in the ground for a second cutting should be avoided in infected areas.

*B. Solanacearum* was also found attacking potatoes by Coleman in Mysore.

A bacterial disease of wheat in the Punjab locally known as "Tannan" or "Tandu" was investigated; this was found to be due

to the attack of a bacillus closely resembling *Ps. Hyacinthi* which invests the opening ear with a sticky growth causing deformation and stunting and preventing ripening of the grain. The attack is confined to small badly drained areas and can probably be avoided by proper cultivation; its distribution is limited and it is probably of no economic importance.

**Disease of Eri Silkworms.**—A disease of eri worms resembling "flacherie" was found to be associated with the presence of bacteria in the intestine. Investigation showed that the immediate cause of disease was improper dieting leading to indigestion; this was aggravated by a thickening of the peritrophic membrane due to invasion of the latter by bacteria, and resulting in impairment of digestion by suppression of secretion of the digestive fluids.

Experimental infection with cultures of bacteria isolated from the intestine did not produce results sufficiently conclusive to warrant the assumption that these bacteria were an immediate cause of the disease. Enquiries made in various districts in Assam where the disease is well known, confirmed the conclusion that improper diet is its immediate cause.

*List of Publications.*

HUTCHINSON, C. M. . Studies in Soil Bacteriology. No. 1. (*Mem. Dept. of Agriculture in India, Bacteriological Series, No. 1, 1911-12.*)

,, ,, Rangpur Tobacco Disease. (*Mem. Dept. of Agriculture in India, Bacteriological Series, No. 2.*)

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,, ,, A Bacterial Disease of Wheat in the Punjab. (*Journ. of Agricultural Science, Vol. V.*)

# FORESTRY.

## I.—SYLVICULTURE.

BY

R. S. TROUP, F.C.H.,

*Sylviculturist.*

**Statistical work in typical forest crops.**—Good progress was made during the year in the collection of statistics by measurements in sample-plots laid out in typical forest crops in the United Provinces, 53 permanently demarcated plots and 43 temporary plots having been laid out and measured. The principal species dealt with were *Shorea robusta, Cedrus Deodara, Pinus excelsa, Pinus longifolia, Quercus incana, Quercus dilatata* and *Quercus semecarpifolia.* The objects of these measurements are the ultimate compilation of yield-tables giving the average rate of development of forest crops, of different types and qualities, in girth, height and volume, and the determination of the frequency and intensity of thinnings which will produce the maximum volume increment per acre per annum. The want of such statistics has rendered it impossible hitherto to ascertain the most profitable rotations on which to work forest crops of different kinds in India: without some accurate forecast of the kind there is no alternative but to go by guess work, a proceeding which may involve heavy financial loss. The value of accurate statistical work is well recognised in European forestry, the result being the highest possible return on the forest capital and a maximum net annual yield per acre. Although the general application in India of all the scientific methods known to economic forestry in Europe is at present out of the question, there are nevertheless many types of forest where these principles could be applied, and the extension of statistical work, with this end in view, is greatly to be desired. This work is, so far as present conditions admit, now almost completed in the United Provinces, and it is proposed to extend it to other Provinces during the coming season.

**The sal tree (Shorea robusta).**—The sylviculture of the *sál* tree continues to be the subject of special investigation, and various experimental plots in the forest, dealing with the natural reproduction of the tree, are under observation. Some preliminary tests were carried out throughout the principal *sál* tracts of India with a view to ascertaining to what extent the fertility of *sál* seed is influenced by the size, condition and environment of the seedbearers. The results tend to show that neither the size of the trees, nor their degree of soundness,

nor the locality, soil, aspect, and type of forest in which they grow, have any appreciable effect on the fertility of the seed produced by them.

**Financial results of plantations.**—Ever since its initiation the Forest Department has been engaged in planting operations in various parts of India. Some of these plantations have been formed after due consideration, and with the idea of yielding good financial returns: on the other hand there can be no doubt that much loss has been incurred through haphazard planting operations without sufficiently accurate financial forecasts. There are now sufficient *data* available, with respect to many of the more important plantations of India, for affording means of gauging their financial success or otherwise, and ascertaining the factors contributing towards success or failure. With the co-operation of the Divisional Forest Officers concerned a commencement has been made with this important work, a large number of measurements having been carried out in the Eucalyptus plantations of the Nilgris and in the teak plantations of South Malabar: the statistics collected are under compilation, and will be published when complete.

**Teak forests of Burma.**—An examination of the statistics contained in all existing working-plans for the natural teak forests of Burma has been made, and the results were published during the year. In the 6,105 square miles of teak-bearing forests dealt with it is a striking fact that the three forests richest in teak trees 3 feet in girth and over are on flat alluvial land, the richest of all being the Mohnyin Reserve in the Katha Division, containing 707 such trees per 100 acres. There are five forests with over 400, and nine with from 300 to 400 such trees per 100 acres. In no case does the average percentage of teak trees 3 feet in girth and over in teak-bearing forests exceed 33 for whole reserves, while in some cases it falls as low as 6; in the Mohnyin Reserve the percentage is probably higher than 33, though the absence of enumerations of species other than teak makes it impossible to substantiate this. In individual sample-plots the enumerations naturally show far greater richness: the plot richest in large sized teak trees, one of 52 acres situated in the Taungnyo Reserve of the Zigôn Division, contained at the time of enumeration no fewer than 689 trees 7 feet in girth and over per 100 acres, while in a plot 20·4 acres in extent in the Mohnyin Reserve 5,560 teak trees 3 feet in girth and over were enumerated.

The beneficial effects of concentrated working on the natural regeneration of teak are strikingly exhibited by the enumerations in the Pegu Yoma forests of the Pyinmana Division, Upper Burma. These forests

were heavily overworked before the British occupation, and the percentage of large trees is small; aided, however, by the openings made in the overwood, the constant breaking down of bamboos by working elephants and the wounding of the soil during extraction, natural regeneration of teak has sprung up in great profusion, the figures showing that in the eight reserves in question in no case does the crop of young trees under 3 feet in girth average less than 768 plants per 100 acres, a result attained in only two other reserves in Burma.

In true teak-bearing forest of the recognised types the average rate of growth is found to be fastest in alluvial forest of the "lower mixed" type and slowest in dry "upper mixed" forest, an average tree 7 feet in girth varying in age from 110 to 190 years. The fastest and slowest rates of growth recorded for individual trees are ages of 42 years and 357 years for trees 7 feet in girth, representing mean annual girth increments of 2·00 and ·240 inches respectively. The average age of a 7 feet tree throughout the whole of Burma is 155 years: here the mean annual girth increment declines steadily from ·621 inches at an age of 58 years, representing a girth of 3 feet to ·542 inches at an age of 155 years. The actual rotations fixed in working-plans vary from 120 to 200 years, after allowance has been made for the time taken for a seedling to establish itself. So far as the results of actual felling operations under the working-plans are concerned, it is found that only in the richest forests does the average yield of marketable teak trees, spread over a series of years, exceed 10 trees of 7 feet girth and over per square mile per annum (that is, per square mile of total teak-bearing forest, not of forest actually worked over). The highest average yield has been furnished by the Mohnyin forest, which has yielded 24 such trees per square mile per annum. The statistics given above exhibit the comparatively small proportion of teak in the natural forests of Burma, and point to the advisability of increasing that proportion as far as is sylviculturally possible and desirable. Measures likely to effect this object were indicated in the report on Sylviculture for 1909-10.

### Developments in Sylvicultural Systems.

**(a) Teak (Tectona grandis).**—A decided advance in sylvicultural methods in Burma has been made by the application of a modification of the system of successive regeneration fellings to the Mohnyin working circle under Mr. H. R. Blanford's working-plan, issued during the year. This is the first time this system has been substituted for the selection system hitherto universally applied to the Burma teak forests. The forest in question is of somewhat abnormal type, consisting as it does to a great extent of almost pure stretches of large sized teak with

little or no regeneration. Experiments extending over several years have shown that regeneration can be induced in abundance by opening the canopy thoroughly and burning the undergrowth, the young crop resulting from these operations being assisted by repeated weedings. The exploitable girth is fixed at 8 feet, and the rotation corresponding is calculated to be 180 years; this rotation is divided into nine regeneration periods of 20 years each. The fellings will take the form of clear fellings over successive small areas until the whole periodic block has been regenerated: it thus differs from the group system and the usual system of successive regeneration fellings in that only one felling, and not a succession of fellings, will be carried out over any given patch dealt with.

**(b) Deodar (Cedrus Deodara).**—Forest Officers in the Punjab have for some time past been confronted with the fact that the selection system has by no means proved a satisfactory one for the working of deodar forests, since this species, from its habit of regenerating freely, and in masses, only if the overwood is drastically opened out, is better adapted for regeneration under the group system than under the selection system. The application of the group system to deodar forests was the subject of discussion at a recent Forest Conference at Lahore: as a result of the discussion it was resolved to await the experience derived from carrying out the prescriptions of recently framed working-plans dealing with that system, before deciding on further details regarding its application.

Mr. C. G. Trevor's working-plan for the Upper Ravi Forests, Chamba State, prescribes the working of deodar under the group system: the rotation is fixed at 140 years, divided into five regeneration periods of 28 years each. The number of successive fellings has been provisionally fixed at four for the period, the interval between them being 7 years.

**(c) Blue pine (Pinus excelsa).**—The same working-plan prescribes the working of blue pine under the group system; the rotation is fixed at 100 years, divided into four regeneration periods of 25 years each. Three successive fellings are considered sufficient to effect regeneration.

*List of Indian Publications, 1911-12.*

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| CHANNER, F. F. R. | . Working-plan for the Terai and Bhabar Government Estates Protected Forests, United Provinces. |
| HOPWOOD, S. F. | . Working-plan for the Ahlaw Working Circle, Upper Chindwin Division, Upper Burma. |
| MAITLAND-KIRWAN, J. D. | The Coppicing Powers of *Babul* (*Acacia arabica*). (*Ind. For., xxxvii, 430.*) |
| OSMASTON, A. E. | . Experiments on Coppicing *Sál* in the Gorakhpur Forest Division, Eastern Circle, United Provinces. (*Ind. For., xxxvii, 434.*) |
| STEVENS, E. R. | . The Uniform System for *Sál* Forest. (*Ind. For., xxxvii, 605.*) |
| TRAFFORD, F. | . Working-plan for the Forests of the Sundarbans Division, Bengal. |
| TREVOR, C. G. | . Working-plan for the Upper Ravi Forests, Chamba State, Punjab. |
| TROUP, R. S. | . A Manual of Forest Mensuration. |
| ,, ,, | . A Note on some Statistical and other Information regarding the Teak Forests of Burma. (*Ind. For. Rec., iii, Pt. I.*) |
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# FORESTRY.

## II.—ECONOMIC FOREST PRODUCTS.

BY

R. S. PEARSON, F.L.S.,
*Forest Economist.*

1. **Technical properties of *sal* timber.**—Specimens of hill and plains-grown *sál*, of seedling and coppice origin, obtained from the United and Central Provinces were sent to Sibpur to be tested. The results obtained so far are not conclusive, so that further specimens are being sent in order to obtain definite results as to the transverse strength and resistance to crushing and shearing of the various varieties of *sál* timber.

*Sál* logs of the above-mentioned varieties were laid down to season under different conditions, and the percentage of moisture in the timber was recorded. They will be inspected from year to year until completely seasoned. At the time when these experiments were commenced, and before the logs were laid down to season, specimens were cut from them to determine the specific gravity of the timber when green and after it had seasoned, and also with which to carry out splitting tests. The splitting tests with green timber were carried out during the year, those on dry timber will be carried out when the timber is thoroughly seasoned.

2. **Outturn, uses, durability and prices of *sal* timber.**—Figures of outturn of *sál* from Government and Private forests were collected during the year and also data as to the average annual number of *sál* sleepers purchased by the various railway systems of India. The Public Works Department officials and others furnished most detailed information on the uses and durability of *sál* timber when used in the open, under cover, in water and when buried in the ground, while the Railway officials furnished details as to the durability of *sál* sleepers, and their resistance to the cutting action of the rail and as to the tendency of the spike to shake loose. Information has also been collected regarding the past and present prices of *sál* timber and sleepers.

3. **Minor products obtained from the *sal* tree.**—The necessary information for a complete Note on the Minor Products obtained from *Shorea robusta* was collected, such as outturn and prices of *sál*

damar, the bark in connection with tanning, and the use of the fibre and leaves.

4. **The match industry.**—The Economist visited several districts in Oudh and after carrying out enumerations, reported on the available supply of suitable timber for match making. The amount available was found to be sufficient to work one or more match factories. Samples of timber from the Sunderbans and Madras were sent to an expert to be tested, and in several instances were found to be most suitable for match-making.

5. **Bamboo paper-pulp.**—This enquiry, which has been in progress for nearly three years, is now practically completed. Many bamboo areas have been inspected on the West Coast in Bombay and Madras, in Burma and Arakan. During the year a further area was inspected by the Economist in Cachar, large quantities of bamboo of different species have been converted into pulp on a commercial scale, and it has been found possible to make a good quality of paper within a working limit of cost.

6. **Antiseptic treatment of woods.**—(*i*) The experimental powellized sleepers, numbering 2,929 in all, have been handed over to the North-Western, Oudh and Rohilkhand and the Eastern Bengal State Railways, and laid down on the lines in order to note their behaviour. The above number of sleepers was made up of 860 *Terminalia tomentosa*, 435 *Dipterocarpus tuberculatus*, 121 *Dipterocarpus alatus*, 704 *Pinus excelsa* and 809 *Pinus longifolia*.

(*ii*) Another experiment has been carried out by treating 2,000 sleepers of the above-mentioned species with *Avenarius Carbolineum* oil. The two species of pine sleepers which were treated by the Economist have been handed over to the North-Western Railway, those treated in Bombay and Burma will be handed over to the Railway authorities in the near future.

(*iii*) An experiment to treat a third set of sleepers by a mixed impregnation method is now in hand.

7. **Tea-boxes.**—The Economist toured in several districts of Assam in order to ascertain the difficulties under which the tea-box industry is carried on in that province. The chief difficulties are the want of accessible timber and the liability of the timber to the attack of insects. Experiments to protect the timber were carried out during the year.

8. **Gums and resins.**—Experiments were carried out to ascertain the best method of tapping *Boswellia serrata*, with indifferent results. It was thought that the hot weather was not a suitable season in which

to carry out tapping operations, so that it is proposed to carry out further experiments during the cold weather of 1912-13.

Many enquiries were received from Europe on the Burmese wood-oil of *Melanorrhœa usitata* and information collected as to the local uses and method of preparing the varnish in Burma.

9. **Miscellaneous uses of woods.**—Samples have been supplied to, and experimented with, by makers of matches, pencils, tool-handles, weaving looms, cement barrels, wood veneers, musical instruments, packing cases, etc., while specimens of canes were sent to a firm and found suitable for cricket-bat handles.

10. **Tan barks.**—Figures of outturn and cost f. o. r. of seven species of tan barks were collected from the various provinces. After ascertaining that one or more of these barks are available in large quantities and at reasonable rates, it is proposed to prepare fair-sized samples of tan extracts for valuation.

11. **Economic and wood museums.**—A large number of specimens were collected for both museums, especially wood specimens. A complete collection of teak specimens from all parts of India and Burma was commenced, the number collected so far being 79. It has not been found possible to arrange the fine collection of timber and minor products received from the Allahabad Exhibition, all that it is possible to do is to house the specimens until the new Research buildings have been erected.

12. **Botanical and other specimens.**—A number of botanical and other forest product specimens were supplied by the Forest Department to various Government Departments, private persons, firms and institutions in India, England, Germany and Australia.

*List of Publications.*


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|---|---|
| Bateman, E. . | . A visual method for determining the penetration of inorganic salts in treated wood. (*U. S. Dept. of Agr. Cir. No. 190.*) |
| Bond, Francis M. | . Progress Report on wood-paving experiments in Minneapolis. (*U. S. Dept. of Agr. Cir. No. 194.*) |
| Brand, C. J. . | . Crop Plants for Paper-making. (*U. S. Dept. of Agri. Cir. No. 82.*) |
| Cline, McGarney | . Strength values for structural timbers. (*U. S. Dept. of Agri. Cir. No. 189.*) |

PEARSON, R. S. . . Note on the Antiseptic Treatment of timber in India with special reference to railway sleepers. (*Ind. For. Rec., Vol. III, Part II.*)

PEARSON, R. S. . . Commercial Guide to the Forest Economic Products of India.

PURAN SINGH . . Note on the Preparation of Tannin Extracts. (*Ind. For. Rec., Vol. III, Part IV.*)

PURAN SINGH . . Method of distinguishing the powellized and the unpowellized wood. (*Ind. For., October 1911, p. 567.*)

PURAN SINGH . . *Podophyllum Emodi.* (*Ind. For., April 1912, p. 156.*)

RAITT, W. . . Report on the Investigation of Bamboo as Material for Production of Paper-pulp. (*Ind. For. Rec., Vol. III, Part III.*)

TEESDALE, C. H. . Volatilization of various fractions of Creosote after their injection into wood. (*U. S. Dept. of Agr. Cir. No. 188.*)

VINCENT, HARRY . Bamboo-pulp as the paper material of the future. (*Ind. For., November 1911, p. 627.*)

WOOLSEY, THEODORE S. Turpentining in Florida on an American National Forest. (*Ind. For., June 1912, p. 280.*)

# ZOOLOGY.

## I.—ZOOLOGICAL SURVEY.

BY

STANLEY KEMP, B.A.,

*Officiating Superintendent, Indian Museum.*

As explained in the introduction to last year's report, this brief account of the zoological research undertaken during the year is drawn up with special reference to that carried out in the Indian Museum, though, with the exception of that of Departments which themselves submit reports to the Board, other work which has a direct bearing on the Fauna of the Indian Empire is not neglected.

**Field work.**—Most of the field work effected during the year has been carried out on the lines indicated in last year's report. The survey of the fresh-water fauna of the Indian Empire has been continued and results of considerable value have been obtained; it was in work of this nature that Dr. Annandale interested himself during a month's leave in Ceylon in October 1911.

Dr. Annandale in company with Mr. F. H. Gravely visited Purulia in February and Puri and Cuttack in March; on each occasion extensive collections were made and the latter tour resulted in the discovery of *Caridinicola*, a new and very curious flat-worm of the order *Temnocephaloidea*, living on fresh-water shrimps of the family *Atyidæ*. In April, Mr. F. H. Gravely in company with Mr. S. P. Agharkar, Lecturer on Biology in the Elphinstone College, Bombay, spent three weeks in the Western Ghats and Konkan. This tour, which was undertaken with the object of again finding the fresh-water Medusa, *Limnocnida*, first discovered by Mr. Agharkar during the previous year, proved eminently successful: the Medusa was found in considerable numbers and valuable observations were made on its habits. Mr. B. L. Chaudhuri paid two visits to Chota Nagpur, chiefly with the object of obtaining specimens of fresh-water Chelonia and information regarding them. Considerable collections were made in this and in other groups.

In November 1911, Mr. S. W. Kemp left on deputation to accompany the Abor Expeditionary Force as Zoologist and Anthropologist, taking with him Mr. Hodgart, Museum Collector, as his assistant. About four months were spent in the Abor country and extensive collections were

made during this period. The most interesting animal obtained is *Peripatus*, a primitive arthropod which was not hitherto known to exist within the limits of the Indian Empire. The zoological results of this expedition are being published in a separate volume of the "Records of the Indian Museum" and it is believed that among them material will be found which will add very considerably to our knowledge of the inter-relationships of the faunas of the various regions of N. E. India.

On previous military expeditions where any biological work, other than of a private character, has been accomplished, it has been effected by a "Surgeon-Naturalist." This is the first time that a separate officer has been deputed for the purpose and it is hoped that the results obtained will be held to justify the deputation of an officer of the Museum on any similar occasion that may arise.

In November and December 1911, Mr. F. H. Gravely visited Tennasserim passing across the Amherst district to the Burmo-Siamese frontier. This tour was principally undertaken in order to obtain information regarding certain *Arachnida* and *Coleoptera* of this little known region: in this respect the results proved most successful and large collections in other groups were also made. The results of this expedition will, wherever possible, be incorporated with those obtained in the Abor country. The existence of a strong Burmese element in the latter region cannot be doubted and additional information regarding the fauna of Tennasserim will certainly have great interest from a comparative point of view.

It is unfortunate that Captain R. B. Seymour Sewell, I.M.S., Surgeon-Naturalist to the Marine Survey, was recalled to Calcutta two months after the survey season had commenced. During the period when he was on board the 'Investigator' he was employed in continuing his observations on the floating fauna and his introduction of a tow-net of exceptionally large size for obtaining extensive samples of plankton from any depth has produced results of a most satisfactory nature. There can be little doubt, however, that if funds were available for the purpose, the provision of some of the specially designed apparatus now used in this type of research in home waters would render the work still more efficient. No officer was appointed to act for Captain Sewell during the remaining five months of the survey season, but seven trawls were made in deep water producing results of considerable interest.

Mr. C. A. Paiva, late Entomological Assistant in the Museum, spent several months in the Almora district, where he made collections of

insects. The loss of this officer's services is seriously felt in the Entomological sub-section.

As in previous years we are under considerable obligation to a number of private collectors, thanks to whose energy a large number of specimens have been acquired for the Museum. His Excellency Lord Carmichael, Governor of Bengal, is taking great interest in the work of the Zoological Section and arrangements have been made for the sorting and, as far as possible, the identification in the Museum of the large collections which he is making in the Darjiling district. It is already evident that his offer to present specimens of any species not hitherto represented in the Museum is a most valuable one.

**Laboratory work.**—During the past four months of the year under review the greater part of the time of the officers belonging to the Zoological Section has been spent in the transference of the reserve collections and library to their new quarters. This work, though laborious, has not been entirely unproductive for it has been found possible in the course of the transference to give more space for the accommodation of the collections and to rearrange the majority of them according to a uniform scheme and thus facilitate in a very great degree their accessibility to students engaged in research. The increase in laboratory accommodation has proved a great benefit, but it is already evident that this increase is none too great for our requirements. At the moment the four spare laboratories which are available are occupied by the Professor of Biology at the Medical College, the Deputy Director of Fisheries, Bengal, the Surgeon-Naturalist to the Marine Survey and by Major A. C. MacGilchrist, I.M.S., officer on special duty in connection with the *Stegomyia* Survey, Port of Calcutta.

A considerable amount of work has already been done in the determination of the collections from the Abor country and it is satisfactory to be able to record that quite a substantial number of groups are being dealt with by specialists in India. As far as work within the Museum is concerned, Dr. Annandale completed exhaustive reports on the *Reptilia* and *Batrachia* prior to going on leave and Mr. Gravely, who has finished his account of the *Scolopendridæ*, is now undertaking the examination of certain other groups with which he is acquainted. The identification of the fish, which has been entrusted to Mr. Chaudhuri, is far advanced, and Mr. E. Brunetti has completed a lengthy report on the *Diptera*. Mr. Kemp's paper on the *Crustacea Decapoda* is almost ready for the press. Mr. E. A. Andrews has determined a considerable part of the large collection of *Hemiptera*, and Mr. C. A. Paiva has identified the *Anthophila*.

Several important papers dealing with the fresh-water fauna of the Indian Empire have been published during the year while others are in course of preparation. Dr. Annandale has completed two papers on the aquatic *Chelonia* and has described the fresh-water *Medusa* from the Western Ghats. Mr. Chaudhuri has continued his studies of Indian fresh-water fish; he has published a paper on the species of sting-rays inhabiting the middle and upper Ganges, their range and breeding habits, and has finished an account of new species of fish from Northern India. Mr. Kemp has published a few short papers on fresh-water Crustacea and done some preliminary work on the Indian fresh-water shrimps of the families *Palæmonidæ* and *Atyidæ*. Of other papers which have appeared during the year or are in preparation special interest attaches to the series which Dr. Annandale has named Fauna Symbiotica Indica, which deals with the taxonomy and more particularly the bionomics of Indian animals found living together in a manner which implies something more than fortuitous occurrence, and to his notes on the fauna of the Parésnath Hills. Mr. Kemp's memoir on the group *Stomatopoda* is now in the press and that by Mr. Gravely on the *Passalid Coleoptera* is almost completed. Mr. Gravely is continuing his work on the Indian *Pedipalpi*.

Captain R. B. Seymour Sewell, who in December was appointed Acting Professor of Biology in the Medical College, has continued his studies on *Copepoda* and a report which, in addition to the taxonomy of the group, comprises some most interesting observations on growth stages and development is now in the press. In collaboration with Mr. B. L. Chaudhuri, Captain Sewell has published a semi-popular brochure on certain fresh-water fish which eat mosquito-larvæ. The importance of this subject from the point of view of public health need not be emphasized.

Mr. E. Brunetti, continuing his fruitful work on *Diptera*, has now completed his volume in the "Fauna of India" series on the *Nemocera* other than *Culicidæ*, *Chironomidæ* and *Cecidomyidæ*. Among the papers which he has recently published special reference must be made to his Revision of Oriental Tipulidæ and to his Supplement to the Catalogue of Oriental Mosquitoes. The descriptions of hitherto unknown species which he has completed during the year under review (both published and in manuscript) amount to over 400.

Captain T. L. Bomford, I.M.S., Acting Surgeon-Naturalist to the Marine Survey, has been occupied since his arrival in Calcutta in the identification of part of the collections recently made by the R.I.M.S. "Investigator."

Mr. T. Southwell, Deputy Director of Fisheries, who is now engaged in reorganising the fishery departments of Bengal and of Bihar and Orissa is in occupation of one of the Museum laboratories. Such time as he is able to spare from administrative duties has been devoted to an enquiry into Cestode parasites with special reference to those of fish. It is hoped that arrangements to publish his more purely scientific papers in the "Records of the Indian Museum" will shortly be completed.

**Bombay Natural History Society.**—The publications of the Bombay Natural History Society have maintained their high standard. The survey of the mammals of India which was inaugurated last year has been prosecuted with vigour as may be seen by reference to the various papers on the subject which have recently been published. It is to be hoped that funds for the continuance of this useful work will be forthcoming. Among the papers of a more popular nature which have appeared in the Society's Journal special reference must be made to Mr. E. C. Stuart Baker's monograph of the game birds of India, Burma and Ceylon and Major F. Wall's treatise on the common Indian snakes. These memoirs are serial in form and both are well illustrated by coloured plates. Work of a more purely scientific nature is not neglected. Important papers such as those of Mr. Rowland E. Turner on Wasps, Mr. E. Meyrick on *Micro-Lepidoptera* and of Sir George Hampson on *Heterocera* will go far to confirm the scientific reputation of the Society at home. As in previous years the Journal abounds in biological notes of great interest.

**Other work.**—As regards other work which has been accomplished during the year, attention may be drawn to the descriptions of new Cestodes by Mr. J. Hornell of the Government Fishery Bureau, Madras, to the two papers on *Oligochæta* by Major J. Stephenson, I.M.S., Professor of Biology in the Government College, Lahore, and to Captain W. S. Patton's researches on the development of *Herpetomonas donovani* in two species of *Cimex*.

**Work done in Europe and America.**—During the year Dr. W. W. Fowler's volume in the Fauna of India series has appeared. It comprises a general introduction to the *Coleoptera* and descriptions of the Indian *Cicindelidæ*, *Paussidæ*, *Rhysodidæ* and *Cupedidæ*. The introduction occupies about half the book and, including as it does synoptic tables and a detailed account of all the families of beetles which are known to occur in India, is certain to prove most useful to those engaged on the study of Coleoptera in this country.

Among other works reference to Colonel Alcock's 'Entomology for Medical Officers' must not be omitted. The book deals primarily—and always in the most lucid manner—with those Arthropoda that are known to influence public health. There can be no doubt that it will admirably fulfil the purpose for which it was written, while even the specialist in entomology will find in it much information that he will value.

In the Indian Museum publications the long memoir on Crinoids by Mr. Austen H. Clark is now ready and Prof. Bezzi's monograph of the Dipterous family *Trypetidæ* is approaching completion. Miss Ricardo has published two important papers on *Tabanidæ* and mention may also be made of Prof. Camerano's paper on Gordiid worms and of Mr. Preston's Catalogue of the Naiades in the Indian Museum collection. The latter is a preliminary work undertaken prior to the completion of an account of the fresh-water Mollusca for publication in the "Fauna of India" series.

*List of Publications with special reference to Indian Zoology, prepared by B. L. Chaudhuri.*

GENERAL.


ANNANDALE, N. . . Notes on the Fauna of Parésnath Hill, Western Bengal. (*Rec. Ind. Mus., vii, 33.*)

,, ,, . . Fauna Symbiotica Indica. (*Ibid., vii, 123, 147 and 243.*)

ANNANDALE, N., & KEMP, S. Observations on the Invertebrate Fauna of the Kumaon Lakes, with special reference to the Sponges and Polyzoa. (*Ibid., vii, 129.*)

HARTLEY, C. . . An exploration of the Beligal-ge, near Balangoda. (*Spolia Zeylan., vii, 197.*)

HICKS, F. C. . Forty years among the Wild Animals of India.

JENKINS, J. T. . Observations on the shallow water fauna of the Bay of Bengal made on the Bengal Fisheries steam-trawler "Golden Crown," 1908-1909. (*Rec. Ind. Mus., vii, 51.*)

MANDERS, N. . An investigation into the validity of Mullerian and other forms of Mimicry with special reference to the Islands of Bourbon, Mauritius

and Ceylon. (*Proc. Zoo. Soc., Lond., 1911, 696.*)

PEARSON, J. . Biological Survey of Trincomalee Harbour. (*Spolia Zeylan., viii, 30.*)

,, ,, . The growth of Marine Organisms in Colombo Harbour. (*Ibid., viii, 68.*)

STEBBING, E. P. . Game Sanctuaries and Game Protection in India. (*Proc. Zoo. Soc., Lond., 1912, 23.*)

## PROTOZOA.

ANNANDALE, N. . Occurrence of *Trichodina pediculus* on the manubrium of *Limnocnida indica*. (*Rec. Ind. Mus., vii, 256.*)

PATTON, W. S. . The development of *Herpetomonas donovani* in *Cimex rotundatus* and in *Cimex lectularius*. (*Sc. Mem., Med. and Sanit. Depts., Govt. Ind.*)

## PORIFERA (SPONGES).

ANNANDALE, N. . Notes on Freshwater Sponges. (*Rec. Ind. Mus., vii, 99.*)

,, ,, . Systematic and Geographical Notes on the Sponges of Kumaon Lakes. (*Ibid., vii, 137.*)

,, ,, . Freshwater Sponges and Polyzoa. (*Spolia Zeylan., viii, 133.*)

## CŒLENTERATES.

ANNANDALE, N. . Preliminary Description of a Freshwater Medusa from the Bombay Presidency. (*Rec. Ind. Mus., vii, 253.*)

,, ,, . Note on a Freshwater Medusa from the Western Ghats. (*Journ. Asiat. Soc., Beng., vii, cxxiii.*)

## ECHINODERMATA.

CLARK, A. H. . On a small collection of recent Crinoids from the Indian Ocean. (*Rec. Ind. Mus., vii, 267.*)

## VERMES.

ANNANDALE, N. . . Caridinicola, a new type of Temnocephaloidea. (*Rec. Ind. Mus., vii, 243.*)

,, ,, . . A Leech parasitic on the Hard-shelled Pond Tortoise of Ceylon. (*Spolia Zeylan., viii, 134.*)

CAMERANO, L. . . Gordiens du Musée Indien. (*Rec. Ind. Mus., vii, 215.*)

HORNELL, J. . . New Cestodes from Indian Fishes. (*Rec. Ind. Mus., vii, 197.*)

KHAN, M. . . . Notes on the rearing of leeches in Mawai, Bara Banki District, United Provinces. (*Rec. Ind. Mus., vii, 206.*)

LLOYD, R. E. . Some disputed points in the anatomy of a common Indian earthworm. (*Journ. Bomb. Nat. Hist. Soc., xxi, 289.*)

POWELL, A. . . Note on above paper. (*Journ. Bomb. Nat. Hist. Soc., xxi, 291.*)

SOUTHWELL, T. . A description of ten new species of Cestodes Parasites from Marine Fishes of Ceylon, with Notes on seven other species from the same region. (*Ceylon Marine Biol. Repts., i, 259.*)

STEPHENS, J. W. . The Liver-Fluke of the Indian Pariah Dog. (*Ann. Trop. Med. and Parasit., Ser. T. M., vi, No. 1, B., 117.*)

STEPHENSON, J. . . On a new species of *Branchiodrilus* and certain other aquatic Oligochæta, with remarks on cephalization in the Naididæ. (*Rec. Ind. Mus., vii, 219.*)

,, ,, . . Earthworms of Yunnan based on collections made by J. Coggin Brown. (*Rec. Ind. Mus., vii, 273.*)

## CRUSTACEA.

HENDERSON, J. R. . Description of a new species of freshwater crab from Southern India. (*Rec. Ind. Mus., vii, 111.*)

KEMP, S., & SEWELL, R. B. S. Notes on Decapoda in the Indian Museum with special reference to the species obtained by the R.I.M.S. "Investigator" during 1910-1911. (*Ibid., vii, 15.*)

KEMP, S. . . . Notes on Decapoda in the Indian Museum. (*Ibid., vii, 113.*)

,, ,, . . *Apus* from the United Provinces. (*Journ. Asiat. Soc., Beng., vii, cxi.*)

PEARSON, J. . . Notes on the Alpheidæ. (*Spolia Zeylan., vii, 169.*)

WALTON, H. J., & KEMP, S. Notes on the occurrence of *Apus* in Eastern Asia. (*Rec. Ind. Mus., vii, 310.*)

## ARACHNIDA.

GRAVELY, F. H. . . Mimicry of a Mutillid by a spider. (*Rec. Ind. Mus., vii, 87.*)

,, ,, . . Notes on Pedipalpi in the collection of the Indian Museum. (*Ibid., vii, 110.*)

,, ,, . . Remarks on the distribution of Pedipalpi. (*Journ. Asiat. Soc., Beng., vii, cxxiii.*)

GREEN, E. E. . . On a remarkable Mimetic Spider. (*Spolia Zeylan., viii, 92.*)

HIRST, S. . . . Descriptions of new Scorpions. (*Ann. Mag. Nat. Hist., viii (1st Ser.), 462.*)

## INSECTA.

ALCOCK, A. . . Entomology for Medical Officers.

ANNANDALE, N. . . A new genus of short-beaked gnats from Ceylon. (*Spolia Zeylan., vii, 187.*)

,, ,, . . Further notes on flies of the genus *Phlebotomus*. (*Ibid., vii, 203.*)

,, ,, . . Description of a Micropterous fly of the family Phoridæ associated with ants. (*Ibid., viii, 85.*)

ANTRAM, C. B. . . *Pœcilocoris latus*, Dall., *and Pœcilocoris hardwickii*, Westw. (*Quart Journ. Ind. Tea Assoc., pt. iv, 1911, 14.*)

ARROW, G. J. . . On some new species of the Lamellicorn Genus *Anomala* from Sikkim, North India. (*Ann. Mag. Nat. Hist., ix (8th Ser.), 1912, 72.*)

,, ,, . . Some new species of the Coleopterous Genus *Anomala* from Southern India. (*Ibid., viii (8th Ser.), 473.*)

,, ,, . . Descriptions of some new Burmese species of Rutcline Coleoptera belonging to the genus *Anomala*. (*Ibid., x (8th Ser.), 327.*)

BELL, T. R. . . The common Butterflies of the plains of India. (*Journ. Bomb. Nat. Hist. Soc., xxi, 517, 740.*)

BERGROTH, E. . . On some recently described Hemiptera chiefly from India. (*Ann. Soc. Entomol. Belgique, lv, 1911, 184.*)

BRUNETTI, E. . . Revision of the Oriental Tipulidæ with descriptions of new species. (*Rec. Ind. Mus., vi, 231.*)

,, ,, . . Annotated Catalogue of the Oriental Culicidæ—Supplement. (*Ibid., vi, 403.*)

,, ,, . . Description of *Aphiochæta ferruginea*, a hitherto undescribed species of Phoridæ that causes Myiasis in Man. (*Ibid., vi, 83.*)

,, ,, . . A new species of blood-sucking Fly (*Simulium*) from Ceylon. (*Spolia Zeylan., viii, 85.*)

BURR, M. . . . Contribution to our knowledge of Indian earwigs. (*Journ. Asiat. Soc., Beng., vii (new series), 771.*)

BUTTEL-RUPEN, V. . Entomologischer Reisebrief aus Ceylon's Bergen. (*Entom. Mitteil., i, No. 4, 1912.*)

DISTANT, W. L. . Descriptions of new genera and species of Oriental Homoptera. (*Ann. Mag. Nat. Hist., viii (8th Series), 639, ix, 181, 459.*)

DRUCE, H. H. . . Description of a new Nymphaline Butterfly from British India. (*Trans. Entom. Soc., Lond., 1911, 187.*)

ELTRINGHAM, H. . A Monograph of the African species of the genus *Acræa*, Fab., with a supplement on those of the Oriental Region. (*Ibid., 1912.*)

EVANS, W. H. . . A list of the Indian Butterflies. (*Journ. Bomb. Nat. Hist. Soc., xxi, 553, 969.*)

FOWLER, W. W. . Coleoptera, General Introduction and Cicindelidæ and Paussidæ. (*Fauna of British India.*)

FRASER, F. C. . . A note on *Polyommatus bœticus*. (*Journ. Bomb. Nat. Hist. Soc., xxi, 288.*)

FRAZER, —— . . Biological Notes on Indian Picrine Larvæ. (*Trans. Entom. Soc., Lond., 1911, xxvi.*)

FRYER, J. C. F. . "Filodes mirificales," a good species. (*Spolia Zeylan., vii, 220.*)

GRAVELY, F. H. . The habits of some tiger beetles from Orissa. (*Rec. Ind. Mus., vi, 207.*)

GREEN, E. E. . . Notes on the collection of Coccidæ in the Indian Museum. The genus *Margarodes*. (*Ibid., vii, 65.*)

,, ,, . On the larval habits of *Toxorhynchites immisericors*. (*Ibid., vii, 309.*)

,, ,, . On the occasional luminosity of the beetle *Harmatelia bilinea*. (*Spolia Zeylan., vii, 212.*)

,, ,, . On an interesting aberration of *Vanessa* (*Pyrameis*) *indica*. (*Ibid., vii, 215.*)

,, ,, . Notes on the larva of *Papilio polytes*. (*Ibid., vii, 217.*)

,, ,, . Note on a web-spinning Psocid. (*Ibid., viii, pt. xxix, 71.*)

GROUVELLE, A. . . Descriptions of five new Clavicorn Coleoptera. (*Rec. Ind. Mus., vi, 315.*)

HAMPSON, G. F. . . The Moths of India. (*Journ. Bomb. Nat. Hist. Soc., xxi, 411, 878.*)

HANCOCK, J. L. . Tettiginæ (Acridiinæ) in the Agricultural Research Institute, Pusa, with descriptions of new species. (*Mem. Dept. Agri., India, iv, No. 2, 1912.*)

HANNYNGTON, F. . Note on the distribution of *Lethe kansa* and *Dophla patala*. (*Journ. Bomb. Nat. Hist. Soc., xxi, 286.*)

HELLER, K. M. . . Eine neue Gattung der Discolomidæ (Coleoptera) aus der Orientalischen Region. (*Philip. Journ. Sc., vii, Sec. D, No. 2, 105.*)

HOLMGREN, N. . . Termites from British India, collected by Dr. J. Assmuth, S.J. (*Journ. Bomb. Nat. Hist. Soc., xxi, 774.*)

HOPE, G. D. . . Note on *Pœcilocoris latus*, Dall., an insect pest of tea. (*Journ. Asiat. Soc., Beng., vii (New Ser.), cxxiii.*)

IMMS, A. D. . . On some Collembola from India, Burma, and Ceylon; with a catalogue of the Oriental species of the order. (*Proc. Zool. Soc., Lond., 1912, 80.*)

KIEFFER, J. J. . . Les Chironomides (Tendipedidæ) de l'Himalaya et d'Assam. (*Rec. Ind. Mus., vi, 319.*)

,, ,, . . Noveaux chironomides (Tendipedidæ) de Ceylon. (*Spolia Zeylan., viii, 1.*)

,, ,, . . Cecidomyies de Ceylon decrites. (*Spolia Zeylan., viii, 25.*)

KROBER, O. . . Die Thereviden der Indo-Australischen Region (Fortsetzung). (*Entom. Mitteil., i, No. 6, 183.*)

LONGSTAFF, G. B. . Butterfly Hunting in many lands.

MANDERS, N. . . A factor in the production of mutual resemblance in allied species of Butterflies; a presumed Mulleriar combination of *Euplœas* in South India and *Amauris* in South Africa. (*Trans. Entom. Soc., Lond., 1911, 417.*)

,, ,, . . Notes on Ceylon Butterflies. (*Spolia Zeylan., viii, 136.*)

MEYRICK, E. . . Descriptions of Indian Micro-Lepidoptera. (*Journ. Bomb. Nat. Hist. Soc., xxi, 104, 852.*)

PAIVA, C. A. . . Materials for a survey of mosquitoes of Calcutta. (*Rec. Ind. Mus., vii, 93.*)

PATTON, W. S., & CRAGG, F. W. The genus *Pristirhynchomyia*, Brunetti. (*Ann. Trop. Med. and Parasit., v, Ser. T. M., No. 4, 509.*)

PEARSON, J. . . Tipulidæ from Ceylon. (*Spolia Zeylan., viii, pt. xxix, 65.*)

RICARDO, G. . . A Revision of the Oriental species of the genera of the family Tabanidæ other than *Tabanus*. (*Rec. Ind. Mus., iv, 321.*)

,, ,, . . Tabanidæ from Yunnan (contributions to the Fauna of Yunnan based on collections made by J. Coggin Brown). (*Ibid., iv, 401.*)

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# ZOOLOGY.

## II.—ECONOMIC ZOOLOGY.

### Part I.—AGRICULTURAL ENTOMOLOGY.

BY

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**Pusa Research Institute.**—The study of the life-histories and habits of injurious and beneficial insects was continued at the Pusa Research Institute, the following species being specially studied:—

1. "Bherwa" (*Schizodactylus monstrosus*, Dr.).
2. Indigo Psylla (*Psylla isitis*, Buck.)
3. Fish Insect (*Lepisma* sp.).
4. White-ants (*Termes* spp.).
5. Grain and Flour Beetles (1. *Rhizopertha dominica*, Fabr.). (2. *Tribolium ferrugineum*, F. & T.). (3. *Lœmophlœus testaceus*, F.).
6. White Weevil (*Myllocerus maculosus*, Dasbr.).
7. Green Weevil (*Astycus lateralis*, Fabr.).
8. Cotton Stem Weevil (*Pempheres affinis*, Fst.).
9. Small Rice Grasshopper (*Oxya velox*, Fabr.).
10. Green Surface Grasshopper (*Atractomorpha crenulata*, Sss.).
11. White-banded Grasshopper (*Epacromia dorsalis*, Thunb.).
12. Mango Leafhopper (*Idiocerus*) 3 species.
13. *Ascalaphus* sp.
14. *Rhogas lefroyi*, Ashm. Ms,

Work on fruit flies was continued by the staff of the Imperial Pathological Entomologist.

In addition to the above some important field observations were made on the Sugarcane Fly (*Pyrilla lycoides*, Wlk.) and the Sugarcane Mealy Wing (*Aleurodes barodensis*, Mask.). Observations have also been recorded on pests occurring generally in India and a minute record kept of those occurring on the Pusa Farm.

At the request of the Bihar Planters' Association, an enquiry into the *Psylla* disease of indigo was taken up and is being continued. The experiments on the preservation of wood and other materials from the attacks of Termites (White-ants) are still in progress, and the efficacy of various preparations and the relative immunity of different kinds of wood is being tested. A new process was devised and proved effectual; it is the only wood treatment yet found wholly to resist White-ant attack. Some experiments with White-ants, which attack wheat and sugarcane crops, were also conducted. In conjunction with the Department of Agriculture, Bihar and Orissa, active part was taken in combating the "Surface Caterpillar" pest (*Agrotis ypsilon*, Roth.) which did enormous damage annually to "rabi" crops in the Mokameh Tal lands; and as a result of the remedial measures adopted the loss this year has been considerably reduced. The Andres-Maire system of trapping has been of great value in this campaign; it is still uncertain where this pest passes the monsoon period. Assistance was given to the Department of Agriculture, Punjab, in checking an outbreak of the Cotton Bollworm (*Earias insulana*, Boisd.) in that Province. It was anticipated that the cold winter of 1910-11 would be followed by a bollworm outbreak, and that parasites would be absent; the parasite was accordingly introduced and the measures adopted were attended with great success, the parasite, *Rhogas lefroyi*, Ashm. Ms., of the Cotton Bollworm being introduced. established and spread throughout the affected areas. Fuller information has been gained of this Cotton Bollworm and its parasites during the course of this campaign.

The experiments in crossing multivoltine and univoltine races of Mulberry Silkworms to secure a superior silk-producing multivoltine race have been continued; up to the present it has been impossible to produce a stable multivoltine race of worms, but progress has been made and the problem is narrowed down and more likely to be solved. Acclimatized univoltine races were successfully reared on pruned tree mulberry, wild mulberry and bush mulberry and arrangements have been made to distribute eggs of these univoltine races for rearing in

October. The cultivation of the eri silkworm was continued and experiments with crossing *Attacus ricini* and *A. cynthia* were performed with a view to obtain a hardy race of worms which will successfully stand the climatic conditions of Bihar. After repeated trials it has been found that the crosses are influenced in the same way as pure eri worms, and do not show any special advantage over the latter. It has been necessary to show the commercial possibilities of eri silk and a part of the energies of this Section is devoted to designing superior fabrics as models for those who have taken up the industry.

Experimental work in Lac-culture and the collection of the races of lac insects, in collaboration with the Forest Department, were continued. It is hoped that the material collected by Forest Officers will enable the problem of lac races to be solved.

Investigations into Apiculture have been continued. In November 1911 two colonies of American-Italian bees were imported and these have proved very successful; but so far all attempts to obtain fertilised queens for multiplying the colonies have failed, apparently on account of the activities of bee-eating birds which are common at Pusa. The yield per hive was high, but it has been impossible to get fertile queens, these being destroyed on the marriage flight; if queens can be imported this difficulty will be overcome. Trials have been made with the common Indian bee (*Apis indica*, F.) and success has been achieved in adapting the modern bar-frame hive to its requirements.

**Provincial Departments.**—In Madras experiments were continued for the control of the Deccan Grasshopper (*Colemania sphenarioides*, Bol.). Special attention has also been paid to the observations and rearing of the natural enemies of this grasshopper. Considerable damage having been caused to Cambodia cotton in the Coimbatore District by the attack of the Stem Weevil (*Pempheres affinis*, Fst.), a considerable amount of work has been done on its life-history with a view to control, but no satisfactory method of dealing with it has been found as yet. Some research work on Termites was carried out and in the course of this it was noted that the open-chambered termitaria found at Coimbatore regularly harbour numerous specimen of Sand-flies (*Phlebotomus minutus*) which probably breed in the débris collected in the galleries of the mound.

In Bombay experiments were carried out to devise best means of checking the ravages of two insect pests which considerably damage some valuable crops in Ahmedabad and Kaira Districts. These insects are (1) Katra (Hairy Caterpillars of which *Amsacta moorei*, Butl. is most prominent) and (2) the White-ants (*Termes* sp.).

In Baroda the campaign against "Katra" (*Amsacta* spp.) was continued.

From the Central Provinces the parasite *Rhogas lefroyi* was issued to the Punjab and Pusa. The cultivation of Eri Silkworms was experimentally tried and the work in connection with the mound-building Termites was continued at Hoshangabad.

In the North-West Frontier Province very successful spraying experiments against the Peach Aphis were conducted; and the efficacy of Maize as a trap crop for the Sugarcane Borer (*Chilo simplex*, Butl.) was tested.

In the Punjab vigorous measures were adopted to check an outbreak of the Cotton Bollworm (*Earias insulana*, Boisd.).

In the United Provinces methods of controlling the Potato Moth (*Phthorimæa operculella*, Zell.) were demonstrated, and also active measures were taken against *Hieroglyphus furcifer*, Serv., a serious pest of Sugarcane, in the Province. One Deputy Collector has been put on special duty at Shahjehanpur to work up the Eri Silk industry.

In Bihar and Orissa the campaign against the Surface Caterpillar pest (*Agrotis ypsilon*, Rott.) of the Mokameh Tal lands was continued and great success has been achieved in reducing the extent of damage done by the pest. Successful demonstrations of the methods of controlling the Potato Moth were given at the several Exhibitions and Shows which were held during the year under review, in the Province. Eri Silk cultivation was also taken up and some progress has also been recorded in this direction.

In Bengal several investigations were undertaken including "Ufra" disease of Rice, the Rice Ear-cutting Caterpillar (*Cirphis unipuncta*, How.) and the Mango Hairy Caterpillar (*Cricula trifenestrata*, Helf.).

In Burma, experiments to control the Peach Fly (*Dacus ferrugineus*, Var.) and to destroy the mound-building species of White-ants were conducted. The cultivation of Eri Silkworms was also experimentally taken up at Mandalay, without success.

In Mysore the Entomological staff of the Department of Agriculture was mainly occupied in the supervision of the extensive bagging operations against the Deccan Grasshopper (*Colemania sphenarioides*, Bol.) and the Rice Grasshopper (*Hieroglyphus furcifer*, Serv.) on both of which pests bulletins were issued. The investigations of the Kumblihula pest (*Amsacta albistriga*, Wlk.) have, with the end of this year, been

completed and the more important results have been embodied in a preliminary report issued in June this year. In the Insectary, work was mainly confined to various store pests and to experiments in devising remedies against them. The free living *Bruchid* and the Thogari Pod Fly have also been studied. Further rearing of *Opatrum depressum* has yielded very interesting results. Other insects of minor importance have been studied:—*Episomus lacerta, Orthacris acuticeps, Cryptophlebia carpophaga.*

**Indian Tea Association.**—The Entomologist to the Indian Tea Association investigated the question of damage done to Tea-chests by boring Beetles and the best means to prevent it. An enquiry into the injury to Tea seeds by the Tea Seed Bug (*Pœcilocoris latus*, Dall.) ard the study of Mosquito Blight in the Duars were also taken up.

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## II.—ECONOMIC ZOOLOGY.

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### Part II.—FOREST ENTOMOLOGY.*

BY

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### A.—Sanctioned Programme.

The sanctioned programme of research work consisted of the following items:—

(1) The study of all insects which cause serious damage to, or which are beneficial to the *sál* tree or its timber.

(2) Investigations regarding the lac insect.

(3) The preparation of a satisfactory reference collection of insects for the Research Institute.

(1) **Sal investigation.**—The writer toured in the *sál* forests of the Siwalik and Kheri Forest Divisions, United Provinces, during December 1911—March 1912.

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* Mr. R. S. Hole officiated as Forest Zoologist from July to October 1911, after which period the present writer was appointed.

A good many insects likely to have economic importance have been collected and information relating thereto is being recorded in the research files. The longicorns *Æolesthes holosericea* and *Hoplocerambyx spinicornis* are the only widely distributed insects at present found to cause any lasting damage to the mature *sál*, and special attention is being devoted to the life-history of the first-mentioned species. From affected *sál* logs collected in the Siwalik forests during the cold weather of 1911-12 the mature beetles emerged in breeding cages in Dehra Dun from 13th April to 7th May 1912. Both *Hoplocerambyx spinicornis* and *Æolesthes holosericea* have been found to occur plentifully in the United Provinces and have been recently bred out in considerable numbers from one and the same tree.

Several dead *sál* trees containing larvæ of *Æolesthes holosericea* were felled at Thano, Siwalik Forest Division, United Provinces, and some parasitic Hymenoptera were bred out of these. The specimens were sent to Mr. P. Cameron, a leading authority, for identification, and have been identified by him as *Paroligosthenus trichiopthalmus*, gen. et sp. nov. Parasitic Hymenoptera collected from *sál* leaves at Kaluwalla, Siwalik Forest Division, have proved to belong to two new species of the genus *Iphiaulax* and have been described by Mr. Cameron as—

(1) *Iphiaulax sál*, sp. nov.

(2) *Iphiaulax Immsii*, sp. nov.

Their descriptions along with those of others bred out of lac, are being published as a Forest Record.

So far as at present ascertained, the *Monophlebus* scale and the *Pammene* moth larva are much more local pests. Specimens of the *Monophlebus* scale were received from the Pilibhit Forest Division of the United Provinces, and among them were discovered a large number of the larvæ of a species of Coccinellidæ (genus *Vedalia*), which, on their receipt, were found to have devoured a considerable proportion of the scale insects.

Some lepidopterous larvæ defoliating *sál* leaves were also received from the Pilibhit Forest Division. Three moths (family *Bombycidæ*) were bred out of these, and are at present awaiting identification.

Specimens of caterpillars and moths defoliating *sál* leaves were received from Mr. A. E. Osmaston, Divisional Forest Officer, Gorakhpur Division. The moth was identified as *Ingura subapicalis*, Walker. The other specimens being larvæ could not be identified with any amount of

certainty. From this Division specimens of a beetle (family *Curculionidæ*) attacking *sál* fruits were also received. The specimens have been sent to Mr. Marshall who is at present working at the Fauna of India volume on the family.

Caterpillars of the Noctuid moth *Ingura subapicalis*, Walker, were reported as doing damage to *sál* coppice forests of Chakia Range in the Bahraich Forest Division.

(2) **Lac investigation.**—Specimens of stick lac were received from the Sylviculturist and numerous parasitic insects were bred out of these. A large number of parasitic Hymenoptera, new to science, were bred out. These have been named and described by Mr. P. Cameron as follows:—(1) *Chalcis tachardiæ*, sp. nov., (2) *Cyclopleura claripennis*, gen. et sp. nov., (3) *Eurytoma pallidiscapus*, sp. nov., (4) *Brasema annalicaudis*, sp. nov., (5) *Lissencyrtus troupi*, gen. et sp. nov., (6) *Copidosoma? clavicornis*, sp. nov., (7) *Hadrothrix purpurea*, gen. et sp. nov., (8) *Bracon tachardiæ*, sp. nov., (9) *Ectadiophatnus tachardiæ*, gen. et sp. nov., (10) *Apanteles tachardiæ*, sp. nov.

Their descriptions are being published as a Forest Record.

Specimens of *Butea* stick lac were received from various Divisional Forest Officers of the Central Provinces, and the parasites are being bred out therefrom. A special study is being made of these parasites and their bearing on the production and propagation of lac.

In consequence of the fact that much of the literature at present available contains numerous errors relating to this insect, and very little first hand information, a study is being made of the structure and biology of the lac insect with special reference to Butea lac.

(3) **Reference collection.**—During the year 40 parcels of specimens were despatched to various specialists in Europe and America for identification. Among the specimens identified, the following new species, in addition to those mentioned above, have been described:—

(*a*) Cicadidæ by Mr. W. L. Distant—(1) *Khimbya immsi*, sp. nov., (2) *Dunbulia helena*, sp. nov., (3) *Quintilia pomponia*, sp. nov., (4) *Meimuna cassandra*, sp. nov.

(*b*) Dermaptera by Dr. Malcolm Burr—*Pseudisolabis immsi*, sp. nov.

(*c*) Staphylinidæ by Dr. Max Bernhauer—(1) *Medon immsi*, sp. nov.

(*d*) Hymenoptera by Mr. P. Cameron, F.E.S.—(1) *Centrochalcis ruficaudis*, sp. nov. (Chalcididæ), (2) *Cylopleura fumipennis*, gen. et sp.

nov. (Chalcididæ), (3) *Caloteleia rufipes*, sp. nov. (Scelionidæ), (4) *Immsia carinifrons*, gen. et sp. nov. (Scelionidæ), (5) *Lophyrus indicus*, sp. nov. (Tenthredrinidæ), (6) *Salius dehraessis*, sp. nov. (Pompilidæ), (7) *Liris nitidus*, sp. nov. (Sphegidæ), (8) *Trypoxylon ornatipes*, sp. nov. (Sphegidæ), (9) *Icaria annulipes*, sp. nov. (Vespidæ), (10) *Megachile stirostoma*, sp. nov. (Apidæ).

## B.—Investigations outside the Sanctioned Programme.

1. **Major Subjects.**—(*a*) A species of Coccid attacking Chir pine in the Naini Tal Forest Division. The attack has been found to be both serious and widespread. The life-history of the Coccid is under investigation, and the writer has toured through Kumaon during May and June 1912 in this connection.

(*b*) A study of the various species of Termites found in Indian forests. Specimens of white-ants and notes relating to the damage wrought have been received from nearly all parts of India. Professor Dr. F. Silvestri of Portici, Italy, has undertaken to do the work of identification.

(*c*) Scolytidæ attacking Blue pine (*Pinus excelsa*) and Chir pine (*Pinus longifolia*) in the Chakrata Forest Division, reported by the Divisional Forest Officer.

2. **Minor Subjects.**—(*a*) The beetles *Xylotrupes gideon* from *Poisiana regia* trees, and *Baladiva walkeri*, Waterh., received from the Divisional Forest Officer, Meiktila Division, Burma.

(*b*) A Chrysomelid beetle, reported as devouring *Boswellia serrata* leaves, from the Poona Forest Division.

(*c*) *Monophlebus tamarindus*, Green, found on *Tamarix* and *Prosopis*, received from the Sukkur Forest Division, Sind.

(*d*) Bruchid beetles attacking seeds of *Albizzia amara* and *Albizzia Lebbek*, received from the Bellary Forest Division, Madras.

(*e*) *Trilocha varia*, Walker, defoliating *Ficus elastica* leaves, received from the Conservator of Forests, Northern Circle, Madras. There is no previous record of this moth attacking *Ficus elastica*.

(*f*) The longicorn beetles *Epepeotus uncinatus*, Gahan, and *Haplohammus punctifrons*, Gahan, attacking rubber plants in the Lakhimpur Forest Division. There is no previous record of these beetles attacking rubber plants.

(*g*) Scale insects (probably a new species of *Pulvinaria*) attacking Nim trees in Mayo College, Ajmer. The Noctuid moth *Eublemma scitula*, Rmbr., parasitic on the scale insects, was bred out at the Research Institute.

(*h*) Two species of Bostrichid beetles, *e.g.*, *Sinoxylon anale*, Les., and a larger species closely allied to, or likely only a variety of, *Sinoxylon crassum*, Les., attacking shisham logs in Dehra Dun.

(*i*) Scolytid beetles attacking Padauk logs in the Andamans.

(*j*) Hepialid (?) larvæ, reported as boring into the stems of teak saplings, from the South Malabar Forest Division, Madras.

(*k*) The larvæ of the Noctuid moth *Ingura* (*Abrostola*) *subapicalis*, Walk., defoliating *sál* coppice forests of Chakia Range, Bahraich Forest Division.

(*l*) Curculionid beetles attacking *sál* fruits in the Gorakhpur Forest Division.

(*m*) Some caterpillars and the Noctuid moth *Ingura subapicalis*, Walk., reported as defoliating *sál* leaves from the Gorakhpur Forest Division.

The insects bred out of seeds of *Cassia fistula*, *Albizzia Lebbek*, *Dalbergia paniculata* and *Bauhinia malabarica*, sent by the Sylviculturist, mentioned in last year's report, were identified as follows:—

(1) Out of *Cassia fistula* seeds—*Caryoborus gonagra*, Fabr., *Trachylepidia fructicassiella*, Rog.

(2) Out of *Albizzia Lebbek*—*Stathmopoda basiplectra*, Meyr., sp. nov.

(3) Out of *Dalbergia paniculata*—*Bruchus theobramæ*, L.

(4) Out of *Bauhinia malabarica*—*Caryoborus gonagra*, Fabr.

From among the insects bred out of sundri wood mentioned in last year's report the longicorn beetles and parasitic Hymenoptera have been identified as follows:—

Longicornia (1) *Diorthus simplex*, White, (2) *Derolus discicollis*, Gahan.

Parasitic Hymenoptera (3) *Centrochalcis ruficaudis*, Cam., gen. et sp. nov., (4) *Paroligosthenus trichiopthalmus*, Cam. gen. et sp. nov.

The Buprestid beetles bred out of this wood have been sent to Dr. Ch. Kerremans of Brussels for identification.

3. **Miscellaneous.**—The following are the only additions to the Museum collection during the year worth mentioning:—

(*a*) Mounted specimens of rats and hares damaging Babul seedlings in the Buldana Division.

(*b*) Ants' nest, received from Mr. A. J. Butterwick, Burma.

(*c*) Termites' nest, received from the Haldwani Forest Division, United Provinces.

Specimens have been contributed during the year to the British Museum, Indian Museum, Pusa, and to several specialists.

About 1,600 research files have been opened and the information relating to each insect has been recorded therein.

A Card Index Catalogue of all insects recorded up to date as being injurious to the more important Indian forest trees has been prepared and completed.

Help in the identification of various insects has been generously given by Sir George Hampson, Mr. G. J. Arrow, Mr. Gahan, Mr. C. Morley, Dr. Malcolm Burr, Dr. Max Bernhauer, Professor F. Silvestri, Mr. W. L. Distant, and Dr. W. W. Fowler.

*List of Publications on Economic Zoology.*

| | | |
|---|---|---|
| Bainbrigge Fletcher, T. | | Weevil and Dry Wheat. (*Agri. Journ. Ind., October 1911.*) |
| ,, | ,, | A simple Honey-Extractor. (*Agri Journ. Ind., October 1911.*) |
| ,, | ,, | The Wax Moth. (*Agri. Journ. Ind., October 1911.*) |
| ,, | ,, | The Cabbage White Butterfly. (*Agri. Journ. Ind., January 1912.*) |
| ,, | ,, | The Moth-borer in Canes. (*A pamphlet published by the Dept. of Agri., United Provinces.*) |
| Coleman, L. C. | . | *The Rice Grasshopper. (*Mysore Entomological Bull. No. 1.*) |
| ,, | ,, | *Jola or Deccan Grasshopper. (*Mysore Entomological Bull. No. 2.*) |

* Publications which were mentioned in the last year's report but issued during the year under review.

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| COLEMAN, L. C. . | . "Kumblihulas" attacking crops in Mysore (*Amsacta albistriga*, Wlk.). (*Mysore Entomological Bull. No. 3.*) |
| DE, M. N. . | . Grasserie in Silkworms. (*Agri. Journ. Ind., July 1911.*) |
| DEPARTMENT OF AGRICULTURE, BENGAL. | Leaflet in Bengali on the Rice Ear-cutting Caterpillar (*Cirphis unipuncta*). |
| DEPARTMENT OF AGRICULTURE, BIHAR AND ORISSA. | Leaflets in English and Hindi on the Surface Caterpillar pest (*Agrotis ypsilon*) of Mokameh Tal lands. |
| ,, ,, | Leaflets in Bengali and Ooriya on the Potato Moth (*Phthorimœa operculella*). |
| DEPARTMENT OF AGRICULTURE, BURMA. | Leaflets in English and Burmese on:—<br>1. The Common Hairy Caterpillar (*Diacrisia obliqua*).<br>2. Fruit Flies.<br>3. The Spotted Bollworm of Cotton.<br>4. The Brown Coccid on Cotton.<br>5. Field Crickets. |
| DEPARTMENT OF AGRICULTURE, MADRAS. | Leaflets in English on:—<br>1. Light traps.<br>2. Bambachu (*Leptocorisa varicornis*) and how to combat it.<br>3. Cocoanut Beetles. |
| DEPARTMENT OF AGRICULTURE, PUNJAB. | Leaflets in English, Urdu and Gurmukhi on the Cotton Bollworm. |
| DEPARTMENT OF AGRICULTURE, UNITED PROVINCES. | Short articles in Urdu on:—<br>1. Cut Worms in Tobacco, Potato and Poppy fields. (*Mufid-ul-Muzarain, January 1912.*)<br>2. Termites. (*Mufid-ul-Muzarain, February 1912.*)<br>3. Rice Grasshopper. (*Mufid-ul-Muzarain, March 1912.*) |
| DUTT, H. L. . | Insect Pests of Jute. (*Bengal Quarterly Journ. Agri., October 1911.*) |
| ,, ,, | Swarming Caterpillars on Paddy at Sabour. (*Bengal Quarterly Journ. Agri., January 1912.*) |

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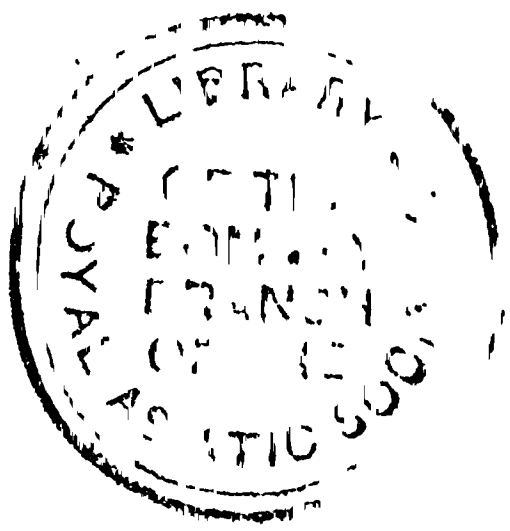
| GHOSH, C. C. | . *Life-Histories of Indian Insects, III. The Rhinoceros Beetle and the Red Palm Weevil. (*Mem. Dept. of Agri., India, Entomological Series, ii, No. 10.*) |
| HOLE, R. S. | . Note on the Bark-boring beetle attack in the coniferous forests of the Simla Catchment Area. (*For. Bull. No. 12.*) |
| INDIAN TEA ASSOCIATION. | Damage by Beetles in Tea Chest Woods. (*Pamphlet No. 1, 1912.*) |
| IYER, V. S. | . Note on some Casuarina Insect Pests of Madras. (*For. Bull. No. 11.*) |
| KHAMPARIA, R. R. | . Moth-borer in Sugarcane, Juar and Maize. (*Agricultural Gazette of Cent. Prov., July 1911.*) |
| MACKENNA, J., & SHROFF, K. D. | The Rhinoceros Beetle and its ravages in Burma. (*Burma Agri. Dept. Bull. No. 4, 1910.*) |
| MAXWELL-LEFROY, H. | Bulletin No. 23 on Insecticides, 2nd edition, revised by T. Bainbrigge Fletcher. |
| MAXWELL-LEFROY, H., & GHOSH, C. C. | *Eri Silk. (*Mem. Dept. of Agri., India, Entomological Series, iv, No. 1.*) |
| MISRA, C. S. | . Cotton Bollworms, an Article in Urdu. (*Mufid-ul-Muzarain, March 1911.*) |
| NOWROJEE, D. | . *Life-Histories of Indian Insects, II. Some Aquatic Rhynchota and Coleoptera. (*Mem. Dept. of Agri., India, Entomological Series, ii, No. 9.*) |
| STEBBING, E. P. | . Note on some Insect Pests of the Himalayan Coniferæ (*Pinus longifolia*). (*For. Mem., Vol. ii, Pt. ii.*) |
| ,, | The Blue Pine Tomicus Bark-borer. (*For. Bull. No. 5.*) |
| ,, | Note on the Bark-eating and Root-boring beetles of Babul. (*For. Bull. No. 10.*) |
| WOODHOUSE, E. J. | . The "Potato Moth" in Bengal. (*Bengal Quarterly Journ. Agri., January 1912.*) |


* Publications which were mentioned in the last year's report but issued during the year under review.



## VETERINARY SCIENCE.

BY

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The following table shows the output and issue of the various products at the Imperial Bacteriological Laboratory at Muktesar:—

| Name. | Quantity prepared. | Issued. |
|---|---|---|
| | Doses. | Doses. |
| Anti-Rinderpest Serum | 1,052,500 | 698,100 |
| Anthrax Serum | 28,722 | 6,070 |
| Hæmorrhagic Septicæmia Vaccine | 33,700 | 33,700 |
| Anti-Hæmorrhagic Septicæmia Serum | 30,845 | 28,970 |
| Charbon Symptomatique Vaccine | 60,000 | 15,350 |
| Mallein | 20,644 | 16,480 |
| Tuberculin | 519 | 577 |
| Anti-Streptococcic Serum | 1,294 | 2,298 |

**Rinderpest.**—Major J. D. E. Holmes, M.A., D.Sc., M.R.C.V.S., has been chiefly employed during the year in studying the new method of preparing Anti-Rinderpest Serum which was reported last year. With a view to improving the technique for this purpose he has investigated the potency of serum taken after natural recovery from plains cattle and buffaloes and from hill cattle; the comparative value of serum taken at repeated bleedings and also the most suitable volume of virus for injection purposes. The system of preparation noted last year has been adopted as a routine method for India. It has proved to be far superior to the older method. Plains cattle and buffaloes which yield a far larger amount of serum than hill bulls can be utilized and consequently a very much larger quantity of serum can be prepared at less expense and labour.

We are now free from the incubus of the hill bull problem to a great extent and the necessity for a new serum laboratory does not exist

as the quantity of serum which it is possible to prepare at Muktesar is sufficient to meet the requirements of the country for some years to come.

Captain R. C. Cochrane, A.V.C., has been engaged in the immunization of military cattle against Rinderpest by the simultaneous method and has published a very valuable contribution to our knowledge of the effect of the use of the serum in the field. The special value of the report lies in the fact that as the cases were under observation continuously correct records were kept and consequently the information is reliable. The lowest dose for plains cattle at present is 5 c.c. per 600 lbs. body weight, the calculation being made at $\frac{1}{18}$, the dose required to protect the most susceptible bovine in India, *i.e.*, the hill bull, but Cochrane considers the calculation for plains should be not $\frac{1}{18}$ but $\frac{1}{5}$ or thereabouts, giving a standard plains dose of 20 c.c. This is the dose fixed by the Conference on Anti-Rinderpest Inoculation for military dairy cattle. It seems probable that it would be fair to issue at a minimum dose of 10 c.c. per 600 lbs. body weight and that a dose of 20 c.c. should be used in dairy cattle or at the beginning of an outbreak. Captain Cochrane's report fixes the average susceptibility in plains cattle at the old estimate, *i.e.*, 30 to 40 per cent. of mortality in untreated cases and 60 to 70 per cent. of considerable immunity. If Anti-Rinderpest serum is used early in an outbreak when the more susceptible animals have to be protected a dose of 20 c.c. is necessary. When the operations are undertaken late, the more susceptible animals have been attacked and only the resistant remain. In such cases a smaller dose suffices, and probably 10 c.c. is the safest.

Owing to the increased output of serum the restrictions in regard to its issue and the prohibition of sale to outside countries have been removed and a larger amount has been issued during the year.

A charge of two annas per dose has been imposed: this is borne by Provincial Governments in all Provinces except the Punjab where a charge is made to the peasant.

**Hæmorrhagic Septicæmia.**—During the winter at Bareilly, Major Holmes made experiments regarding the vitality of the Hæmorrhagic Septicæmia virus outside the animal body and the means by which infection is retained and disseminated. The investigations are not yet complete and are being continued.

Recent observations at Hissar point strongly to the fact that the bacterium is not communicated by means of an invertebrate intermediary

host, but is purely soil-borne and remains alive for a very long time in wet soil, in fact that it can live as a saprophyte as is generally supposed.

Mr. S. H. Gaiger collected a considerable amount of information regarding the connection of outbreaks of the disease with rainfall and has proved conclusively that although the disease is more prevalent after rain it occurs quite independently of it.

Major F. S. H. Baldrey in collaboration with Dr. P. Hartley records experiments regarding a sensitised vaccine for the disease, the sensitising being accomplished by means of a heated specific serum to avoid bacteriolysis. The vaccine thus prepared appears to give immediate immunity thus obviating the objectionable negative phase. Such a vaccine would be very valuable in India as it would supplant serum which is of very doubtful value as a means of dealing with the disease in the field.

Major G. K. Walker submitted a short report on observations of the use of the serum in the field. The issue is at present only in an experimental stage.

**Anthrax.**—Major J. D. E. Holmes reports that during the winter at Bareilly, further experiments were carried out regarding the value and practical application of sero-vaccination against Anthrax by means of a combined injection of serum and virus or serum and a vaccine and that the experiments are being continued.

The serum manufactured is chiefly issued to Eastern Bengal and Assam for use against actual outbreaks. The disease does not appear to be very prevalent in other places.

**Surra.**—Major Holmes has treated a few more naturally acquired cases in equines on the old lines, the result being 68 per cent. of recoveries. The treatment of Surra by this method may be relied on to give from 50 to 60 per cent. of recoveries when the conditions are favourable. The cases must be got pretty early, placed in a good climate, be rested and well fed during the treatment, otherwise the results are disappointing and do not justify the expense.

Experiments have been made in the treatment of Surra in the dog by means of Salvarsan, but the drug does not appear to be a satisfactory one for the purpose.

Mr. A. S. Leese, M.R.C.V.S., the officer investigating camel diseases, has continued his investigations into the curative treatment of Surra in the camel. Early in the year it had been recognised that cures had been obtained by the use of judicious combinations of Atoxyl

or Soamin, Tartar emetic and Sodium arsenate or Arsenious acid. The more recent experiments have been attended by considerable success, 30 camels cast from camel corps have been cured and a percentage of 50 to 62 obtained—a very great advance.

This officer made a long tour in Sind and a short one in Baluchistan for the purpose of collecting information regarding the prevalence of the disease in those Provinces and has submitted a report on the subject.

**Kumri.**—Major Holmes reports that he is investigating this disease in collaboration with Professor Mott, F.R.S., who is carrying out the pathological portion. No definite results have so far been obtained.

**Spirochætosis.**—Spirochætosis of fowls is a very fatal and widespread disease in India. In view of the fact that expensive English fowls are being imported into the country and as they are specially susceptible, Mr. Leese made experiments with a view to finding a cure. He reports that Soamin in $\frac{1}{4}$ to $\frac{1}{8}$ of a grain according to size of the fowl will, if injected into the breast muscles, cure a case.

**Piroplasmosis.**—Mr. S. H. Gaiger has published a paper on the experiments made in the Punjab Veterinary College regarding the treatment of canine piroplasmosis by means of Trypanblau. His experiments appear to confirm Patton's observations regarding the presence of two species of piroplasms in the dog in India, one destroyed by Trypanblau and the other unaffected by it.

Considerable success has been obtained in Madras by Major Symons, I.M.S., and Captain Patton in the treatment of the disease by Salvarsan.

**Filariasis.**—Mr. A. S. Leese has continued his studies into camel filariasis as it occurs in India and has published a paper describing the parasite, the effects of the embryos on the host, the duration and course of the disease produced and discussing the probable agent of infection. The paper is a valuable contribution to our knowledge of the subject.

**Parasites.**—Mr. Leese reports the occurrence of Bilharziosis in the camel. *Thelazia leesei* (Raillet & Henry) has also been described as an extra ocular nematode of the camel.

The same author reports on the probable connection between Linguatula larvæ and Peritonitis in the camel.

Mr. S. H. Gaiger records the occurrence of a new extra ocular filaria of the dog, which has been named *Thelazia callipæda* (Raillet & Henry).

The same observer has found a new nematode in sheep and cattle. The parasite belongs to a new sub-genus and a new species and has been named *Gaigeria pachyscelis*.

Some investigations have been made regarding the percentage of infestation of the dog and the treatment of parasitism.

*A List of Papers published during the year 1911-12 bearing on Indian diseases.*


BALDREY, F. S. H. Feeding and immunity in Hæmorrhagic Septicæmia and Rinderpest. (*Journ. Trop. Vet. Science, vi, No. 2.*)

" " A culture method for hyperimmunizing animals for the production of Anti-Rinderpest Serum. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Sensitised vaccine in Hæmorrhagic Septicæmia. (*Journ. Trop. Vet. Science, vi, No. 3.*)

The evolution of *Trypanosoma evansi* through the fly: *Tabanus* and *Stomoxys*. (*Journ. Trop. Vet. Science, vi, No. 3.*)

An undescribed organism pathogenic to laboratory animals, cattle and sheep. (*Journ. Trop. Vet. Science, vi, No. 3.*)

BALFOUR, ANDREW . The rôle of the infective granule in certain protozoal infections as illustrated by the Spirochætosis of Sudanese fowls. (*Journ. Trop. Med. & Hyg.*)

Various subjects. (*Report of the Wellcome Research Laboratories.*)

BRUCE, SIR DAVID, HAMERTON, BATEMAN & MACKIE. Trypanosome diseases of domestic animals in Uganda "Trypanosoma pecorum." (*Proc. Roy. Soc., vol. 82 B. 558.*)

Experiments to ascertain if cattle may act as a reservoir of the virus of sleeping sickness *Tr. gambiense*. (*Sleeping Sickness Commn. Rep.*)

Trypanosome diseases of domestic animals in Uganda—II, III *Tr. vivax*, IV *Tr. uniforme*, V *Tr. nanum*.

*Trypanosoma gambiense* development in *Glossina palpalis*. (*Proc. Roy. Soc., Series B, 85 B. 567.*)

Experiments to ascertain if certain *Tabanidæ* act as the carriers of *Trypanosoma pecorum*. (*Proc. Roy. Soc., B. 565.*)

Experiments to ascertain if antelope may act as a reservoir of the virus of *Trypanosoma gambiense*. (*Sleeping Sickness Commn. Rep.*)

Amakebe, a disease of calves in Uganda. (*Journ. R. A. M. C., 10, No. 5.*)

BURTON CLELAND, J. Endemic hæmaturia in cattle due to Angiomata in the bladder; its possible relation to Pentastomiasis. (*Journ. Trop. Vet. Science, vi, No. 2.*)

An early reference suggestive of the transmission of disease (Trypanosomiasis) by flies. (*Journ. Trop. Vet. Science, vi, No. 2.*)

BURTON CLELAND, J., & HARVEY JOHNSTON, T. On the anatomy and possible mode of transmission of *Filaria (Onchocera) gibsoni*. (*Proc. Roy. Soc. N. S. W., xliv.*)

COCHRANE, R. C. . Inoculation against Rinderpest in India by the serum simultaneous method. (*Journ. Trop. Vet. Science, vi, No. 2.*)

CONDER, G. . . Treatment of Anthrax by hypodermic injections of carbolic acid. (*Journ. Trop. Vet. Science, vi, No. 4.*)

DARLING, SAMUEL T. . Equine Trypanosomiasis in the Canal zone. (*Bull. de la Soc. de Path. Exot., iii, No. 6.*)

The probable mode of infection and the methods used in controlling an outbreak of equine Trypanosomiasis (Murrina) in the Panama Canal zone. (*Parasitology, 10.*)

DELANOE, P. . . Présence de trypanosomes chez les bovidés en France. (*Bull. de la Soc. de Path. Exot., iv.*)

DUBOIS, M. . . Divers cas de Fièvre de Malta d'origine ovine, chez l'homme. (*Rev. Vet., 9.*)

FANTHAM, DR. . . The life-history of *Trypanosoma gambiense* and *T. rhodesiense* as seen in rats and guinea-pigs. (*Proc. Roy. Soc., 83, B.*)

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| FRANCA, C. . | . Classification des Piroplasmes. (*Archiv. do Real. Inst. Bact. Cam. Pest., iii.*) |
| | Description de deux formes des piroplasmes. (*Archiv. do Real. Inst. Bact. Cam. Pest., iii.*) |
| | Sur un Trypanosome de Lérot. (*Archiv. do Real. Inst. Bact. Cam. Pest., iii.*) |
| GAIGER, S. H. . | . Notes on Parasites. (*Journ. Trop. Vet. Science, vi, No. 3.*) |
| | Canine piroplasmosis. (*Journ. Trop. Vet. Science, vi, No. 4.*) |
| GILCHRIST, J. D. F. . | The intermediate host of the liver fluke in South Africa. (*Natal Agric. Journ.*) |
| GILRUTH, J. A. . | . Note on a protozoan parasite found in the mucous membrane of a sheep. (*Bull. de la Soc. de Path. Exot., iii, No. 5.*) |
| | Note on the existence of Spirochætosis in fowls in Victoria. (*Proc. Roy. Soc. Vict., 23, p. 1.*) |
| GOGEL, L. S. . | . *Filaria immitis* chez les chiens de Transcaucasie. (*Zeits. fur wissen ü prakt Vet., iii.*) |
| HARMS, ERIC . | . Chemo-therapeutische Versuche bei der Nagana. (*Arch. fur wissen. und Prakt Tier, 96, 4 & 5.*) |
| HARVERY, W. F., & MARKHAM CARTER, R. | Pyocyaneus infection in dogs and its similarity to rabies. (*British Med. Journ.*) |
| HECKINROTH, F. | . Essai d'obtention d'une race de Nagana résistante à l'émétique. (*Ann. de l'Institut Pasteur, xxiv.*) |
| HERRING, L. . | . Texas tick fever and Brahma cattle. (*Amer. Vet. Rev.*) |
| JOWETT, WALTER | . Note on a Cattle Trypanosomiasis of Portuguese East Africa. (*Journ. Trop. Vet. Science, vi, No. 2.*) |
| LAFONT, A. . | . Récherches sur le surra a Maurice. (*Apercu general sur le travail du Lab. de Bact., Maurice.*) |
| LAUFRANCHI, ALEXANDRA. | Studi ematologica in cani affeti sperimentale da Surra. (*Le Clinica Vet., xxxiii, Nos. 4, 5 & 6.*) |

LAVERAN, A.

Au sujet de *Trypanosoma dimorphon* et de *Trypanosoma Congolense.* (*Bull. de la Soc. de Path. Exot., iii.*)

*Trypanosoma cazalboui* ne doit pas être identifie à *Trypanosoma vivax.* (*Bull. de la Soc. de Path. Exot., 10.*)

Au sujet de *Trypanosoma brucei* sans blepharoplast. (*Bull. de la Soc. de Path. Exot., 10.*)

Du traitement par l'orpiment des infections produites par *Trypanosoma Congolense* et *par Trypanosoma dimorphon.* (*Bull. de la Soc. de Path. Exot., iii.*)

De l'efficacité d'un emetique d'arsenic et d'aniline dans le traitement de différente trypanosomiases. (*C. R. de l'Acad. des Sciences, 151, No. 13.*)

Resistance des chêvres et des moutons aux trypanosomiases : longue durée de l'immunité à la suite de ces maladies. (*C. R. de la Soc. de Biol., 152.*)

Contribution à l'étude de *Trypanosoma hippicum* (Darling). (*Bull. de la Soc. de Path. Exot., iv* )

Au sujet de *Trypanosoma pecorum* (Bruce). (*Bull. de la Soc. de Path. Exot., iii.*)

Identification and an attempt to classify the Trypanosomes of Mammals. (*Annales de l'Institut Pasteur, J. T. V. S., vii.*)

LEESE, A. S.

Indian Camel filariasis. (*Journ. Trop. Vet. Science, vi, No. 4.*)

Bilharziasis in the Camel. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Soamin treatment of Indian fowl spirochætosis. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Linguatula larvæ and peritonitis in the Camel. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Third series of experiments on treatment of Surra in Camels. (*Journ. Trop. Vet. Science, vii, No. 1.*)

LEESE, A. S. . . Biting flies and Surra. (*Journ. Trop. Vet. Sciencе, vii, No. 1.*)

Second note on the treatment of Indian fowl spirochætosis. (*Journ. Trop. Vet. Science, vii, No. 1.*)

Annual report of the Veterinary Officer investigating Camel diseases.

LEVADITI, C., & NATTAN LARRIER. Traitement de la piroplasmose canine par Arsenobenzol. (*Bull. de la Soc. de Path. Exot., iii.*)

LUCET, M. . . . Sur la présence de spirochetes dans un cas de gastro-entérite chez le chien. (*C. R. de l'Acad. des Sciences, 151, No. 3.*)

MARTIN, G., & RINGEMBACH. Étude expérimentale du *Trypanosoma Congolense*. (*Bull. de la Soc. de Path. Exot., iv.*)

MASON, F. E. . . Sarcocysts in the Camel in Egypt. (*Journ. Comp. Path. & Ther.*)

Note on the Camel Trypanosomiasis of Egypt and results of first series of experimental drug treatment. (*Journ. Comp. Path. & Ther., xxiv, No. 1.*)

MATHIS, C., & LEGER, M. Nouvelles récherches sur *Leucocytozoon sabrazesi* et *Leucocytozoon cautleryi* de la poule domestique à Tonkin. (*Bull. de la Soc. de Path. Exot., iv.*)

*Fasciolopsis buski* au Tonkin. (*Bull. de la Soc. de Path. Exot., iv.*)

MELLO, UGO . . Un cas de Toxoplasmose du chien observe à Turin. (*Bull. de la Soc. de Path. Exot., iii.*)

MESNIL, F. . . The identification of some Pathogenic Trypanosomes. (*Bull. de la Soc. de Path. Exot., iii.*)

De l'action comparé de serums de Primates sur les infections à Trypanosomes. (*C. R. de la Soc. de Biol., lxix.*)

MITTER, S. N. . . Note on *Gnathostomum spinigerum*. (*Parasitology, v, No. 2.*)

*Demodex bovis*. (*The Vet. Rec., xxiv, No. 1240.*)

The anatomy of *Gnathostomum spinigerum*. (*Calcutta Med. Journ.*)

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# APPENDIX.

## REPORT ON THE SCIENTIFIC AND TECHNICAL INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED 30TH SEPTEMBER 1912.

BY

W. R. DUNSTAN, M.A., LL.D., F.R.S.,

*Director, Imperial Institute.*

The scientific and technical investigations which have been in progress at the Imperial Institute for India during the year ended the 30th September 1912 are as follows:—

**Opium.**—In connection with the chemical investigation of Indian opium which has been conducted at the Imperial Institute, it has been found necessary to devise a new method of estimating codeine in opium, and a paper on the subject has been communicated by Mr. A. E. Andrews of the Scientific Staff of the Imperial Institute to the Society of Public Analysts, and published in the "Analyst" (1911, Volume 36, page 489).

A series of botanical specimens of the varieties of poppy cultivated in India for the preparation of opium was forwarded from the Imperial Institute to Kew for identification. It was found that all the specimens represented varieties of the true opium poppy, *Papaver somniferum*, Linn.

Samples of Indian medicinal opium have been supplied by the Imperial Institute to a London hospital for practical trial in comparison with Turkey opium, but the results of the experiments are not yet available.

**Solanaceous Drugs.**—A paper giving the results of special scientific interest obtained in the course of the work on Solanaceous drugs, alluded to in previous reports, has been communicated by Mr. A. E. Andrews of the Imperial Institute Staff to the Chemical Society of London and published in the Society's Transactions (1911, Volume 98, page 1871).

**Tobacco.**—In continuation of previous investigations, two further samples of tobacco from the Government Farm at Burirhat were received

for examination and valuation. Both samples were found to be of marketable quality as pipe tobaccos, whilst one of them might be suitable for use as a cigar "wrapper." A London firm of tobacco merchants expressed a desire to be placed in touch with exporters of this tobacco in India, and were referred to the Director General of Commercial Intelligence at Calcutta, who had forwarded the specimens.

During the year the Imperial Institute procured for the Director of Agriculture at Dacca typical samples of various tobaccos marketed in London, to be used as standards of quality at Burirhat.

**Tanning Materials.**—A sample of *Acacia Catechu* extract prepared experimentally in Gwalior was found to contain a low percentage of tannin, due to the extract having been insufficiently concentrated. Suggestions for the improvement of the extract were made in the report.

**Essential Oils.**—Lemongrass oil. In continuation of the action previously taken, a second small consignment of this oil, distilled from four varieties of lemongrass grown at Wahjain, was forwarded to the Imperial Institute for examination and sale in London. The greater part of the consignment was disposed of to a firm of soap-makers at 4*d.* per oz., and the remainder at the same price to a dealer in essential oils who wished to have a small quantity for submission to customers. This dealer subsequently informed the Imperial Institute that he was able to place orders for the oil, and was put into communication with the Director of Land Records and Agriculture in Assam with a view to obtaining consignments of the oil from native distillers.

A consignment of cuscus roots (*Vetiveria zizanioides*) from Trichinopoly was examined in order to determine their value as a source of vetiver oil. The roots were found to be of inferior quality, giving a low yield of somewhat abnormal oil, so that it was doubtful whether they would be readily saleable at good prices in Europe.

The chemical examination of the oil of "Nepal sassafras" or "camphor wood," *Cinnamomum glanduliferum*, was completed during the year, the results being of considerable scientific interest. A paper on the chemistry of the oil by Dr. S. S. Pickles of the Imperial Institute has been communicated to the Chemical Society of London and published in that Society's Transactions, 1912, Volume 101, page 1433. The commercial value of the oil was under investigation at the end of the year.

**Turpentine Oil.**—Two samples of crude and rectified turpentine oil, prepared from the oleo-resin of *Pinus longifolia* by the Forest Chemist at Dehra Dun, were examined. The rectified oil appeared to be

quite suitable for paint and varnish-making, but it differed considerably in composition from the best American and French turpentine oils. It would therefore have to be marketed on its own merits as Indian turpentine oil, and in this case it might be expected to realise a price equal to or rather higher than that of good Russian turpentine oil.

Apart from the examination requisite for determining the commercial value of the oil, the study of its chemical constituents has been pursued by Mr. H. H. Robinson of the Imperial Institute, and a preliminary note has been communicated to the Chemical Society of London and published in that Society's Proceedings, 1911, Volume 27, page 247.

**Oilseeds.**—Samples of five oil-seeds, forwarded by the Director of Agriculture at Dacca, were examined and valued. Four of the varieties, *viz.*, "Raina," "Nahar," "Panang" and "Taramani" seeds, would probably find a ready market in the United Kingdom, but, in the case of the first three, technical trials will be necessary to determine their exact value; a larger supply of these seeds was requested in order that this further investigation might be conducted. The "Taramani" seed (*Eruca sativa*) is already known in the United Kingdom and is used as a source of oil.

A consignment of Margosa seed from the United Provinces was found to yield a fat of dark colour and very unpleasant odour. The dark colour, which was due to the fermentation of the seed during transit, could be avoided, and if the odour can be removed by a simple process the fat could be utilised for soap-making. The matter is being further investigated at the Imperial Institute.

A memorandum was furnished to the Officiating Reporter on Economic Products on the composition of Hydnocarpus fats, including that of *H. Wightiana* ("Moratti" seed) from India, showing that these fats are unsuitable for edible purposes.

A paper giving an account of the scientific results obtained in the course of the work on Indian Bassia seeds has been communicated by Mr. R. G. Pelly of the Imperial Institute Staff to the London Section of the Society of Chemical Industry and published in that Society's Journal, 1912, Volume 31, No. 3, February 15th.

**Cotton.**—Samples of cotton from Trichinopoly, Akola (Berar) and Eastern Bengal and Assam were examined during the year. The samples from Akola were of exceptionally high quality, and it was recommended that their cultivation should be encouraged.

**Fibres.**—Samples of Sisal hemp, Sida fibre and Sisal tow, forwarded by the Fibre Expert at Dacca, were found to be of good quality, and similar fibres could probably be sold in large quantities in the United Kingdom. A small consignment of the Sida fibre was subsequently forwarded by the Fibre Expert and was sold in London at £27 per ton. The fibre was however valued at £28 to £30 per ton (July 1912) if shipped in commercial quantities.

A sample of wild plantain fibre from Burma was clean, soft, and lustrous, and would be readily saleable in the United Kingdom; it was suggested that a small consignment should be forwarded to the Imperial Institute for trial sale.

**Minerals.**—Samples of china clay, bauxite, sandstone, red ochre and other minerals were examined and reported on.

**Miscellaneous official enquiries.**—In addition to the foregoing reports, information was furnished during the year to Government officials in India on a variety of subjects, including the following:—

The analysis of feeding-stuffs.

The utilisation of rat-skins.

The commercial value of fish oils, fish stearin, and vegetable oils.

Bamboo pulp as a paper-making material.

The marketing of sandalwood.

The preparation and storage of compressed fodder.

The marketing of barley.

The commercial value of dried bananas.

The determination of prussic acid yielded by beans.

The cultivation of peas and beans in Burma.

Coal prospecting in Gwalior.

Rosa grass distillation in Gwalior.

A number of other miscellaneous enquiries, received from commercial firms and private individuals in the United Kingdom, India and elsewhere, were also dealt with during the year, information being furnished to the enquirers on Indian oil-seeds, tanning materials, minerals, foodstuffs and other subjects.

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**Twenty-fourth Meeting held at Simla on the 12th May 1913.**

The Board agreed to nominate Mr. C. C. Calder, Officiating Director of the Botanical Survey of India, to officiate as Secretary to the Board during the absence of Major A. T. Gage, I.M.S.

The programmes of the various Scientific Departments for 1913-14 were considered and recommended for acceptance by Government. The Board considered that closer co-operation between the Pathological Entomologist and the Zoological Section of the Indian Museum seemed possible and was advisable in the interests of both Departments.

A letter from the Director of the Imperial Institute, London, on the subject of communicating the names of the investigators conducting scientific work at the Imperial Institute next came up for discussion. The arrangement suggested by Professor Dunstan was not considered altogether satisfactory. It was, however, tentatively accepted and it was suggested that all the Departments represented on the Board, when getting reports from the Imperial Institute, should ask to be supplied

confidentially with the names of persons who conducted the investigations on which the reports were based.

The Board accepted the recommendations of Sub-Committee A, that the Director of the Geological Survey should be regarded as the adviser to Government on seismological questions and that existing seismographs should remain under the control of the several departments that are now maintaining them.

## Twenty-fifth Meeting held at Delhi on 12th November 1913.

The Board considered the question of an increased grant towards the upkeep of the Imperial Institute, London. The Board did not consider it desirable to commit themselves at present to a definite statement of further support, but left the matter open until more detailed information was available as to the present condition of the Imperial Institute collections and as to the probable utility of future work and exhibits.

The draft Annual Report of the Board for 1912-13 was considered and after a few minor alterations was approved as was also the revised distribution list of the Annual Report.

On the question of the relation between forests and the retention of atmospheric and soil moisture, a note was put up by the Director-General of Observatories, and on the representations embodied therein, the Board considered that the obstacles in the way of collecting reliable information and the expense involved more than counterbalanced the benefits which might result. They did not therefore recommend undertaking the enquiries at present.

Letters from the Chairman to the Trustees of the Indian Museum and a note by the Superintendent of the Zoological Section of the Museum embodying proposals for the constitution of a Zoological Survey for India were next considered. The Board viewed the constitution of such a survey with sympathy. They agreed in a general way with the proposals submitted, but thought that, in the event of such a scheme maturing, stress should be laid on the relations which were to subsist between the Directorship of the Survey, the Superintendentship of the Museum and the Secretaryship to the Trustees. They did not consider it desirable to lay down as a fixed principle that the Director of the Zoological Survey in particular should continue to be Secretary to the Trustees or Superintendent of the Indian Museum, though he should necessarily in the opinion of the Board be in charge of the zoological collections of the Museum.

S (*i*) 184-21,100-3-13-(E4)—st. Std—Sectt 37

Received from the Assistant Secretary to Government, General Department, Bombay, each of the publication noted below :—

Annual Report of the Sanitary Commissioner with the Govt of India for 1912.

Annual Report of the Board of Scientific Advice for India for the year 1912-13

Signature and Designation of Officer. } Record Keeper

Dated the 191

It is requested that this receipt may be signed and returned as soon as possible to the Assistant Secretary to Government, General Department.

# APPLIED CHEMISTRY.

## PART I.—ECONOMIC AND INDUSTRIAL CHEMISTRY.

BY

D. HOOPER, F.I.C., F.C.S., F.L.S.,

*Economic Botanist, Botanical Survey of India.*

The following is a review of the chemical work conducted during the year 1912-13 irrespective of that undertaken by the Agricultural and Forest Departments of India. There is very little to record on the subject of inorganic chemistry and the present report deals almost exclusively with substances of vegetable origin examined in India and Europe. As usual a considerable amount of research has been prosecuted by professors and students in the universities, and the titles of the published papers which are not, however, directly concerned with industrial chemistry have been included in the bibliography. Where the author's name is not quoted in the following investigations the work has been carried out in the laboratory of the Industrial Section of the Indian Museum, Calcutta. This laboratory, it may be stated, was closed during the year under review.

The material has been arranged according to the following classification:—

1. Natural exudations : gums and resins.
2. Fixed and volatile oils.
3. Dyes and tans.
4. Fibres and paper.
5. Food substances.
6. Drugs.

## I.—Gums and Resins.

**Sarcocolla gum.**—This is one of the most peculiar natural exudations of plants. Exuding from a shrub identified as *Astragalus fasiculifolius*, Boissier, growing in Persia, it is largely exported to Bombay and is used in medicine and for adulterating opium. It is sweetish to the taste and dissolves for the most part in alcohol and in water. It is not a true gum resin or gutta, but consists principally of a glucoside, sarcocollin which differs in properties from saponin and glycyrrhizin.

**Balsamodendron Playfairii.**—This shrub growing in the Somali Coast yields a peculiar soapy gum called "Hotai" which is

sent in large quantities to Bombay. It disintegrates in water forming a persistent lather and is used for washing the hair. It contains an acid resin soluble in ether and saponin. The occurrence of saponin in a natural exudation is peculiar. Another substance of a similar nature was collected on tour in Karachi. This is called "Dakh" and is brought from the Mekran Coast, Persian Gulf, and is also used by women for washing the hair. It differs from the first named in appearance and composition, but contains a resin and saponin as its principal constituents.

## II.—Fixed and Volatile Oils.

**Cotton seed.**—Progress is being made in the cotton seed oil industry judging from the number of mills that have been established during the past few years. The Director General of Commercial Intelligence has sent for examination samples of refined oil, decorticated cotton seed cake and hulls. These were found to have a good appearance and quite up to the standard in composition of similar products in the European and American markets.

**Soy beans.**—Experiments are being continued in the cultivation of soy beans in Northern India. The habits of the plants and the character of the seeds are so various that some care has to be exercised in selecting suitable sites for the different varieties. The Superintendent of the Government Gardens, Kumaon, planted Hollybrook soy beans at Douglas Dale and Ramgarh. Analysis showed that the seeds grown in the first locality gave 18·26 per cent. of oil and those grown at the second locality gave 14·26 per cent. Also samples of gun bean grown at Douglas Dale yielded 18·66 per cent. of oil and when grown at Ramgarh yielded 15·74 per cent. The Director of Land Records and Agriculture, United Provinces, sent samples of the same kind of soy bean grown in four different villages: they afforded 14·3, 12·2, 12·6 and 11·6 per cent. of oil.

**Papaw seeds.**—The seeds of the ripe fruit of Papaw (*Carica Papaya*) which are usually thrown away as useless were submitted to analysis. The small black seeds have a pungent mustard-like odour and yield an allyl compound when distilled with water. They contain over a quarter of their weight of a yellow fixed oil. The centesimal composition is: water 8·2; oil 26·3; albuminoids 24·3; carbohydrates 15·5; fibre 17·0; ash 8·8.

**Litsæa polyantha,** Juss.—This is a small evergreen tree met with from the Punjab along the foot of the Himalayas eastwards to Assam. The seeds yield an oil which is used medicinally. A sample of the fruit from Golaghat, Assam, was examined. The cleaned seeds yielded 21·2 and the kernels 33 per cent. of a white crystalline fat,

melting at 38·5°. The constants were: acid value 98·9; saponification value 244·8; iodine value 34·4. The fat is of a useful nature and consists very largely, like that of other Litsæas, of lauric acid.

**Nephelium Longana,** Camb.—This is the Longan or Ashphal, the fruit of which appears in India in the hot weather. The fresh fruit afforded 13 parts of skin, 60 parts of pulp and 27 parts of seeds in 100. The seeds which are a waste product are sweetish and slightly astringent and contain much starch. Chemical analysis showed them to contain: moisture 10·0; oil 3·86; albuminoids 6·25; carbohydrates 73·76; fibre 3·6; ash 2·5. They are not oil-seeds, but the composition shows them to have a feeding value equal to that of cattle foods.

**Tea seed oil.**—This oil has once more been examined, this time by Mr. A. K. Menon from kernels obtained from Tinsukia, Assam. Petroleum ether extracted 16·1 per cent. of a clear straw coloured oil which deposited solid fats on standing. The oil had the following characters: specific gravity 0·9028; acid value 3·75; saponification value 189·9; Reichert Meissl value 0·56; iodine value 92·7; unsaponifiable 2·65. The solid fatty acids melted at 57·8° and had the mean molecular weight of 267·3.

**Cydnus indicus oil.**—This common black stink bug of India has been examined by Mr. E. R. Watson. The strong and unpleasant odour of the insect is due to an oil which it secretes. The oil has been found to contain a large proportion of non-volatile oil of the same character as other animal oils. It also contains about 1·5 per cent. of an oil volatile with steam consisting of an acid $C_8H_{14}O_2$, probably cycloheptane-carboxylic acid and a small quantity of a non-acid substance. The acid has a strong rancid odour and the non-acid volatile substance has a still stronger odour.

**Artemisia vulgaris,** Linn.—Indian Wormwood oil from Lebong, Darjeeling. The colour is yellowish with a greenish fluorescence and an odour of sage. Examined by Messrs. Schimmel & Co., it was found to be soluble in one vol. of 80 per cent. alcohol. When more than five vols. was added, opalescence ensued and after prolonged standing paraffin crystals separated out of the solution, with semicarbazide-thujone melting at 186° separated from oil. From the odour of the oil it probably contains borneol.

**East Indian bees'-wax.**—Messrs. Buchner and Fischer have published the results of analyses of a large number of samples of East Indian bees'-wax or "Ghedda" wax. The wax is derived from *Apis indica*, *A. dorsata* and *A. florea*, and differs widely in composition from ordinary bees'-wax, chiefly the product of *A. melifica*. The wax gives abnormal analytical figures in that the ratio between the acid value and the ester value is 12 or higher, and the wax contains glycerides and

neutral substances which might from analytical data be mistaken for ordinary bees'-wax containing adulterations. The results confirm those arrived at by Mr. Hooper who described the sources and composition of Indian bees'-wax in Agricultural Ledger No. 7 of 1904.

## III.—Dyes and Tans.

**Cotton flowers.**—A. G. Perkin has investigated the colouring matter of Indian cotton flowers (*Gossypium herbaceum*) and finds it to be due to gossypetin and quercetin. Gossypetin is also present in the flowers of Egyptian cotton and *Hibiscus Sabdariffa*. The formula is $C_{15}H_{10}O_8$. Fused with alkali it gives pyrocatechuic acid and on oxidation it affords gossipitone in dull red or maroon coloured needles which proved to be a quinone.

**Tagetes patula.**—Mr. Perkin has also examined the flowers of the African Marigold grown in India. Quercetagin was isolated from the flowers by Latour and Magnier de la Source (*Bull. Soc. Chem.*, 1877, 28, 33) who gave it the formula $C_{27}H_{22}O_{13}$. Perkin finds that the main quantity of the colouring matter is present in the petals as a glucoside, and the colouring matter itself $C_{15}H_{10}O_8$ was isolated from this. It yields protocatechuic acid on fusion with alkali. It is a hexahydroxyflavonol isomeric with myricetin, but differs from this colouring matter and also from the closely allied quercetin in that it possesses a tetrahydroxy-benzene in place of the phloroglucinol nucleus which they contain.

**Azo-salicylic acid dyes.**—Messrs. A. C. Sircar and E. R. Watson have contributed two papers on Azo dyes to the Society of Chemical Industry. Azo-salicylic acid dyes in chrome mordants have excellent fastness to light. There is a marked difference between the derivatives of a hydroxy-naphthoic and 2·3 hydroxy-naphthoic acids, the derivatives of the former being all fugitive, whilst the majority of the derivatives of the latter have very good fastness. All the dyeings have excellent fastness to acids.

**Cæsalpinia digyna.**—Mr. T. A. Faust has given the results of experiments with tan pods, from a bush growing wild in Burma and Assam. The pod cases contain as much as 60 per cent. of tannin, and the leather produced by the material is equal in colour to that made from the best sumach. Colour tests in sheep skins were made with solutions of the entire pods and pod cases; the former did not give a uniform colour owing no doubt to the oil in the beans, but the latter gave leather of a light uniform colour. The light colour of the leather tanned with the material was very little darkened by exposure to light for four weeks in which respect the material shows an advantage over allied products of the same class. It would not be profitable for the tanner

to separate the seeds; the pods, however, could be leached whole as the tannin in the cases is extracted very rapidly and the oil in the seeds would not be removed. The material could be obtained at about £9 10*s.* per short ton, which price compares favourably with that of other materials of the same tannin strength.

**Cassia auriculata or Turwar bark.**—The analysis and uses of this South Indian tanning material has formed the subject of a paper by Mr. P. V. Mehd. The maximum amount of tannin in the bark was 22·1 per cent. and experiments were made with this and myrobalans on English hide. It is concluded that though Cassia bark may not be suitable for fancy leather goods and leather for book-binding, it may be used with advantage for heavy as well as for dressing leathers, giving, when blended with myrobalans, a mellow tannage, a very good, light-coloured leather, which compares favourably with that produced by any of the other blends at present in common use.

**Adulterated leather.**—In connection with this subject Mr. M. C. Lamb has contributed a paper before the Society of Public Analysts on the analysis of various East Indian tanned hides. The analysis of about sixty samples obtained from reliable sources of various tannages of East Indian hides were made with the object of ascertaining what particular tannages are most liable to adulteration by the addition of mineral matter and oil. The results of the various analyses are given in detail and show that the amount of adulteration suspected in these imported tanned hides is not nearly so prevalent as is generally anticipated and understood by the trade.

## IV.—Fibres and Paper.

**Hedychium fibre.**—Among the sources of supply for the manufacture of paper Messrs. Beadle and Stevens have conducted factory experiments on *Hedychium coronarium*, Koenig., a plant of the ginger tribe. This plant is a native of India and is distributed from the Himalayas to Ceylon and Malacca, ascending to 4,000 feet in the Khasia Hills. It grows abundantly in Brazil where its growth is easily developed. If properly cultivated it yields from 6 to 10 tons of dry material per acre, a quantity much larger than other paper-making materials, including bamboo and wood pulp. The papers prepared from *Hedychium* fibre are among the strongest hitherto recorded, equal or superior to the best manila papers, and are particularly suitable for the manufacture of paper yarns for textile purposes. It is an easy pulp to manipulate and can be worked either bleached or unbleached. The fact that the paper in its natural state, without the addition of any materials whatever, can be made to possess grease-proof and self-sizing qualities is a point of commercial importance. Other plants of the same natural order are *Amomum hemisphericum* and *Alpinia nutans*, and these have been

found to possess the natural advantage of Hedychium and more suitable for the manufacture of white paper made from strong sulphite wood pulp.

In this connection a plant received from Assam as growing in large quantity and known as "Adurantum" has been tested. It was identified as *Plecanthus Wightii* of the nettle tribe, and yielded 33·6 per cent. of strong white fibre.

## V.—Food Substances.

**Edible roots.**—The Director of Agriculture and Industries, Central Provinces, collected and forwarded to the Indian Museum an interesting series of tuberous roots eaten by the inhabitants. Some of these being supported by botanical specimens, were identified and found to be new to economic botany. Chemical analyses were made of the more important.

The list included the following:—*Hibiscus* sp. Ban bhendi or Khapsi kand. *Pynocycla glauca*, Linn. Tejraj. *Peucedanum Dhana*, Ham. Kamraj. *Peucedanum glaucum*, DC. Bhojraj. *Eulophia* sp. Bansinghara. *Habenaria platyphylla*, Spreng. Chilam chatta.

The *Hibiscus* root is very mucilaginous and fairly nitrogenous. *Pynocycla* and *Peucedanum* roots belong to the same order as the carrot and are as palatable. The Eulophia and Habenaria roots of the orchid family afford salep which has long been a favourite dish with certain classes.

## VI.—Drugs.

**Atropa Belladonna,** Linn.—It was shown last year that the roots of belladonna plants grown at the Kumaon Botanical Gardens yielded 0·4 per cent. of alkaloid when one year old and 0·45 when two years old. A sample of roots from three-year-old plants was received this year and was divided into thin and thick roots. The former yielded 0·4 per cent. of alkaloid and the latter 0·44 per cent. showing that the root does not increase in alkaloidal content after the second year.

The leaves of belladonna grown in the same gardens were also examined. Leaves from one, two and three-year-old plants afforded 0·48, 0·49 and 0·49 per cent. of alkaloid respectively. This result indicates that leaves from plants of different ages do not show much variation in composition.

**Glycyrrhiza glabra,** Linn.—A sample of liquorice root grown in Baluchistan was tested for solid aqueous extract. This amounted to 27·75 per cent. which is well above the pharmacopœia limit of 20 per cent.

**Calotropis procera.**—Dr. L. Lewin has made a chemical and physiological examination of this common Indian plant. He finds the

active principle, which he designates calotropin, to belong to the class of drugs which act on the heart like *Digitalis*. The substance was not obtained pure for chemical analysis.

**Digitalis purpurea.**—The Foxglove is cultivated on the Nilgiri Hills and the dried leaves have for some years been supplied to the Medical Stores at Madras for the manufacture of official preparations. Digitalis leaves used in Europe are standardised before being used in medicine. A sample of the Indian grown leaves has during the year been sent to London for this purpose, and it is satisfactory to know, from a report received from Dr. W. Harrison Martindale, that the Indian leaves are equal in medicinal activity to those grown in England.

**Euphorbia pilulifera,** Linn.—This is one of the indigenous drugs of India and is a popular remedy for a great variety of affections. Dr. Power and Mr. Browning have submitted the plant to a complete chemical examination. The authors separated the following constituents: essential oil, gallic acid, a new phenolic substance, an amorphous glucoside, a lævorotatory sugar, a trace of alkaloid, triacontane, euphosterol, a new monohydric alcohol, a phytosterol, a phytosterolin, jambulol, melissic acid, and a mixture of acids which appeared to consist of palmitic, oleic and linolic acids. Among the various constituents there is none to which any specific physiological action may be ascribed. Such therapeutic virtues as the plant has been presumed to possess would therefore not appear to depend upon any single substance of a definite chemical character.

**Gymnosporia manna.**—Messrs. J. R. Furlong and L. E Campbell have described a new variety of manna obtained as a white encrustation on *Gymnosporia deflexa*, Sprague. The chief constituent of the manna was dulcitol melting at 188° C. It is interesting to notice that in 1909 Mr. Hooper obtained dulcitol from an encrustation on *Elaeodendron glaucum*. In the latter case the manna was the secretion of an insect *Phromnia marginella*. It is probable that this or some allied insect agency is responsible for the deposit of a saccharine exudation on Gymnosporia as it is on other trees of the natural order Celastrinaceæ which have been found to contain dulcitol. It has been suggested that the Phromnia insect should be encouraged to propagate on plants of this order for the purpose of producing dulcitol on a commercial scale.

**Teak wood.**—Following up the researches made some years ago by Dr. Romanis of Rangoon, Mr. A. C. Sircar has investigated a possible chemical method of distinguishing between seasoned and unseasoned teak wood. The author finds that teak wood saw-dust yields on steam distillation either a crystalline or oily substance or a mixture of the two, the amount of the former as compared with the amount of the latter being a criterion of the amount of seasoning of the sample of wood

examined. The crystals melted between 156° and 160° without decomposition.

**Entada scandens.**—Mr. F. T. Eddingfield has investigated the peculiar use in the Philippine Islands of the bark of Gogo (*Entada scandens*) and its effect on gold and gold solutions. It is used by the natives for panning gold-bearing sands, and it is believed that by its use more gold is recovered by causing the fine gold to settle quickly and not float away. The aqueous solution of the bark contains saponin which forms colloidal gold with a purple solution. Apparently its only agency is the effect of the solution falling on the floating particles of gold in the pan and causing them to sink.

**Plant ashes.**—Several analyses were made during the year of plants ashes having a special reputation for industrial purposes. The ashes of the following plants were tested:—Wormwood (*Artemisia vulgaris*), Bamboo (*Bambusa* sp.), Papaw leave (*Carica Papaya*), Plantain leaves (*Musa sapientum*), Wild Date (*Phœnix paludosa*) and Saltwort (*Suæda maritima*). The ash of the plantain was made a special study, since it has long been used in India as an alkaline mordant, by dhobies in place of soap, by doctors as a medicine, as a crude form of table salt and as a manure. It was therefore considered worthy of enquiry to examine samples of the ash of this plant to discover if they possessed any uniformity of composition and an alkalinity superior to that of other plant ashes. Museum samples were found to have a water soluble extract ranging from 7·94 to 27·51 and insoluble silica from 22·2 to 52·04 per cent. The ash of sample of leaves collected and ignited under supervision were next tested, but these showed striking differences in composition and no single element existed in a constant proportion. The lime, potash and phosphoric acid have a certain value in agriculture and the alkali is useful as a mordant and for detergent purposes, but there is no standard composition peculiar to the plant.

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## PART II.—AGRICULTURAL CHEMISTRY.

BY

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*Imperial Agricultural Chemist.*

### SOILS.

*The gases of swamp rice soils.*(*i*)—An important series of experiments has been in progress during the last four years at the hands of Messrs. Harrison and Subramania Aiyar in Madras on the composition of the

(*i*) Memoir, Department of Agriculture in India, Chemical Series, Vol. III (*in the press*).

gases which are included in the wet paddy lands of certain parts of south India, which together with the biological examination will add very much to our knowledge of the *raison d'être* of the agricultural practice and in places assist in its improvement. The agricultural practice of paddy cultivation varies a good deal in different localities, but frequently it consists in the following sequence of operations; (*i*) admission of water to the land, ploughing, addition of green leaf manure and puddling of the surface layer of soil, (*ii*) removal of the surface water, (*iii*) transplanting the young rice, (*iv*) re-admission of irrigation water after the seedlings have established themselves, and which water is maintained on the land until the crop is nearly mature, (*v*) removal of the water from the land in order to allow the plant to dry up and be harvested.

After the ploughing-in of the green manure, a good deal of gas is formed in the soil and the composition of this gas forms the subject of the first part of the memoir. After the paddy is transplanted and has become established, a film forms on the surface of the muddy soil, which materially affects the composition of the soil gases which reach it. Its character and functions form the subject of Part II.

Restricting the attention to the nature of the gases formed in the soil, these are separated by disturbing the mud. Samples of these gases were obtained by carrying a gas collecting apparatus of suitable design across the field; as the feet disturbed the mud, the released gases passed into the collector. They consist chiefly of nitrogen and methane, and the following examples taken from the numerous ones which the memoir contains will sufficiently illustrate the composition:—

| | | |
|---|---|---|
| Methane | 73·8 % | 64·4 % |
| Nitrogen | 10·9 | 20·1 |
| Carbon dioxide | 14·6 | 3·0 |
| Oxygen | ·7 | 1·0 |
| Hydrogen | *Nil.* | 11·5 |

After the paddy has been transplanted and has become established, the character of the gas mixture changes, the proportion of methane markedly decreases, whilst that of nitrogen increases, and hydrogen production becomes largely inhibited. Thus we find:—

| | |
|---|---|
| Methane | 16·6 % |
| Nitrogen | 78·8 |
| Carbon dioxide | 4·4 |
| Oxygen | ·2 |
| Hydrogen | *Nil.* |

Measurements were made of the relative amounts of gas present in cropped and uncropped land respectively which showed a slightly

greater proportion in the cropped land, though the disparity was not large and the method employed for the purpose was not considered very reliable. The importance of this relationship lies in the fact that (*i*) if less gas is evolved from cropped than from uncropped land, then the production of methane is being interfered with, whilst (*ii*) an increased gas production from cropped land would imply an increased evolution of nitrogen. The question was therefore investigated by means of pot cultures.

It must here be mentioned that when making these cultures it was necessary to stop the formation of the organised surface film, to which more complete reference is subsequently made, because of its complicating influence. Its formation was inhibited by means of a small addition of copper sulphate to the water. Under these restricted conditions, the production of methane progressed until after the paddy seedlings were planted in the jars, when its formation ceased entirely. Concurrently there was a marked decrease in the amount of nitrogen gas evolved. Other measurements showed that manured land produced about three times as much nitrogen as unmanured land. The action of the crop is to restrict the formation of methane and hydrogen either by retarding the rate of fermentation or by a portion of the intermediate products of decomposition being absorbed by the roots. There is also evidence to show that the normal evolution of nitrogen is retarded in a similar manner.

In the ordinary course of events in the field, a film forms on the immediate surface of the mud which varies in different localities, but includes diatoms, usually algæ, and bacteria. It plays the important rôle of an oxygen generator. The quantity of this gas which is formed daily is very considerable, and usually rather greater in the absence of a crop. These processes continue either in the presence or in the absence of manure, but the presence of manure increases the production of oxygen considerably. The roots of the rice plant require oxygen, which is carried from the site of its formation by the surface film in the decending water to the root system, and thus becomes available to the plant.

The authors carried out a series of pot cultures to ascertain the rate at which drainage should pass through paddy land, for it is evident that such descent of the upper water must take place if the above mentioned oxygen is to pass below. These tests showed that the downward movement must be slow. If too rapid, harm resulted. We have thus a fairly good picture of the series of changes which occur:—decomposition of organic matter, utilisation of some of the products of this decomposition by an organised surface film, production of oxygen, transport of this oxygen to the soil by the descending water for the use of the plant roots.

This valuable research appears to have already borne practical fruit, for the Report of the Director of Agriculture,(*ii*) Madras, refers to cases where green manuring has been a failure and which failure is probably explained by an absence of proper drainage, which Messrs. Harrison and Subramania Aiyar have shown to be so desirable.

The investigations are naturally not yet considered by the authors to be complete and are being prosecuted.

## WATER.

*Evaporation from a plane water surface.*—As an accompaniment of the estimations of the water requirements of crops which have been conducted by Dr. J. W. Leather at Pusa for some years, the amount of evaporation from a plane water surface was measured for about three years and the data for 1911 and 1912 have been published.(*iii*) The water surface was provided by a masonry tank 6′ 6″ diam.; the position of the water surface was measured by means of a pointer, which travelled along a groove on a vertical iron pedestal; the distance through which it travels was measured by means of a small wheel travelling along a screw. Differences of ·015 cm. were readily registered. The amount of water percolating through the tank was tested by covering the surface with vegetable oil and was found to be barely measurable in five days and was therefore negligible. The tank was protected from animals by means of wire netting.

The amount of water which evaporated at Pusa was compared with records which have been maintained at Lyallpur by the Irrigation Department and at the Madras Observatory. During the cold weather the daily evaporation at Pusa is very similar to that at Lyallpur, both of which are less than at Madras; during the hot weather it is greatest at Lyallpur and least at Pusa. The total annual evaporation at the three stations was found to be:—

| | |
|---|---|
| Lyallpur . . . . . | 6·42 ft. |
| Pusa . . . . . | 4·12 „ (1911). |
| Do. . . . . | 4·18 „ (1912). |
| Madras . . . . . | 6·34 „ |

An empirical formula was deducted from the Pusa and Lyallpur data.

$E$ = (mm. per 24 hours) $= 2{\cdot}0 (\log t - 1{\cdot}74) + {\cdot}33 (\log D - 1{\cdot}00) + {\cdot}36 (\log W - {\cdot}125)$

in which

$t$ = mean temperature ° F. for day.

$D$ = 100 minus 8 A.M. humidity.

$W$ = mean wind velocity for day.

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(*ii*) Report on the operations of the Department of Agriculture, Madras Presidency, for 1912-13, page 5.

(*iii*) Memoir, Department of Agriculture in India. Chemical Series, Vol. III, No. 1.

This formula yields fairly correct results and depends on meteorological data which are published for many places in India.

## SUGAR.

*The experimental error in sampling sugarcane.*(*iv*)—The more systematic sampling of crops has been examined of late years. Until recently the subject had not been examined mathematically, and the taking of a sample to represent a plot or a field was a matter of the fancy of the operator. Some four years ago Dr. J. W. Leather decided to examine the subject in relation to sugarcane at Pusa in order to ascertain what size of sample must be considered necessary, and in what manner it should be taken, in order to reduce the error to certain limits, and to ascertain what those limits may be expected to be.

The first two seasons' work did not yield very satisfactory information, but this year when the tests were conducted on a different system, a much more definite answer to the questions was arrived at.

It was found that the variation among individual canes all growing contiguously was very great indeed, so much so that some 200 had to be tested before the error from the mean value was reduced to small dimensions. It was anticipated in view of the generally accepted ideas in regard to effect of soil, that if a similar number of canes were taken from points distributed all over a plot of say $\frac{1}{10}$ acre, and still more so if they were taken from over a whole acre, this error would be found largely increased. In the event, however, this was not found to be the case; the variation seems to be but little greater on a large than on a small area. The work was conducted not only at Pusa, but also at the Parsa Factory in the north of Champaran district, and the results agreed well at both places.

Duplicate samples of about 200 canes taken in a well distributed manner showed that the probable error from the mean may be depended on to be not more than $\pm 5$ per cent. sucrose in 995 cases in 1,000. If, however, the size of the sample is reduced to about 50 canes, taken in the same manner, the error was found to rise to about $\pm 2{\cdot}0$ in 5 out of 1,000 cases. The canes must of course be taken from all over the area in any case.

*Date palm sugar.*—A valuable contribution to our knowledge of the date palm sugar industry has been published during the year,(*v*) the author being Mr. H. E. Annett. The survey and experimental work which he carried out relates chiefly to Bengal. The history of the industry shows that it expanded rapidly in the middle of the last century, but since then it has shown signs of declining somewhat.

(*iv*) Memoirs, Department of Agriculture in India, Chemical Series, Vol. III (*in the press*).

(*v*) Memoirs, Department of Agriculture in India, Vol. II, No. 6.

The source of supply in Bengal is almost exclusively *Phœnix sylvestris;* whereas in Madras and Burma *Borassus flabelliformis* chiefly takes its place. Other palms which play a smaller part are *Cocos nucifera* and *Caryota Ureus* in Madras, and *Nipa fruticans* in Eastern Bengal and Burma. Mr. Annett's investigations had to do almost exclusively with the first named, *Phœnix sylvestris.*

The trees are first tapped at an age of 5 or 6 years; the trunk is then about $1\frac{1}{2}$ feet high. Tapping consists in (*a*) the removal of all but the top young leaves from one side of the tree, (*b*) the removal of most of the soft tissue which overlies the sap-supplying inner zone, (*c*) removing, after an interval of some 8 days, a further portion of the outer tissues and (*d*) finally, after a further interval of some 12—14 days, incising into the sap-tissue. The flow of juice is usually taken three nights in succession. It decreases in quantity and frequently in quality on each of these occasions. These succeeding juices are therefore distinguished from one another under the terms "jiran," "dokat," "tekat." After an interval of a further three days, a fresh wound is made and juice again taken for usually three succeeding nights. The tapping season continues from November until sometime in March, the production of juice being greatest during December-January. Mr. Annett estimates the yield of juice per tree per season to be about 170 lbs.

The sugars in the juice were carefully examined and only sucrose and glucose were found. The amounts vary considerably; of sucrose the percentage was found to be as high as 17 per cent. and as low as 7·5 per cent. in the "jiran" juice, whilst it falls as low as 5 per cent. in the "tekat." The proportion also varies in the juice of the same tree a good deal during the night. The proportion of glucose likewise varies within wide limits, being as small as ·3 per cent. and as high as 2 per cent.; great difficulty is, however, experienced in obtaining juice which has not suffered inversion to a certain extent. One of the difficulties of the industry in fact consists in the exposure of the juice to the influence of yeasts and other organisms which commonly cause a serious loss of sucrose. The usual practice is to smoke the pots in which the juice is collected on the tree. This matter formed a subject of special enquiry at Mr. Annett's hands, and will no doubt be taken up by him again, since the protection of the juice in this respect would lead to a considerable improvement in the quantity and quality of the sugar obtained.

Apart from this extraneous influence, both the yield and composition of the juice are affected by other factors. The general atmospheric temperature is one, the greatest yield being obtained during the two coldest months December and January, and any sudden rise of temperature causes a decline; cloudy or rainy weather also causes a decline in the flow. The individuality of the tree, as might be expected, is an important

circumstance and the thickest trees were found to be the best. The effect of soil was not definitely traced, though local opinion favours a clay rather than a sandy soil.

The pots are collected from the trees in the morning and the collected juice boiled down to the consistence of "Rab." Mr. Annett estimates the yield of *gur* per tree per annum at about 21·25 lbs. Calculated to the acre the produce equals some 2·3 tons. During the manufacture of the *gur* there are necessarily some losses of sugar in the same manner as there are in the case of cane juice; these are estimated at about 12·5 per cent.

The refining process is conducted by *Khandsaris* who purchase the *gur* (rab) through middlemen. The earthen pots containing the "rab" are broken and the contents put into large baskets of about $2\frac{1}{4}$ maunds capacity. From these the liquid molasses run off for 3—4 days, after which the sugar is overlaid with wet weed, *Vallisneria spiralis*, which purifies the uppermost layer of sugar in the same way as the weed "sewar," *Hydrilla verticilata*, purifies cane sugar in Rohilkhand. The refined sugar contains from 94—98 per cent. sucrose.

## INDIGO.

The newly issued report(*vi*) of the investigations which have been in progress at Sirseah for some years is the last that will appear; it having been decided to conclude that work. Although this course has been decided upon, the report is more than usually interesting. Its subject matter may be conveniently referred to under the following heads:—

*Physiology.*—Efforts have been made to trace a connection between compounds present in the seed and during germination with the indican of the leaf. These failed. The seeds of *Wrightia tinctoria* and *W. tomentosa* both contain indican; the leaves of the former also contain indican, but those of the latter contain none. No other indigo-yielding plant contains indican in its seed. Moreover, it was not found possible to form indoxyl or any derivative of indoxyl from compounds present in the seed of any of the *indigoferas*.

Experiments were made in the hope that by the aid of stimulants the proportion of indican in the leaf might be increased. Some experiments made in 1908(*vii*) had given rise to a hope that such a result was possible, but no success followed an extension of the experiments.

*Other indigo-yielding plants.*—A large collection of indigo-yielding plants was made and one of these, *Wrightia tinctoria*, as mentioned

(*vi*) Report of the Indigo Research Station, Sirseah, for 1912-13 by Cyril Bergtheil and F. R. Parnell. Published by Bihar Planters' Association.

(*vii*) Annual Report, Board of Scientific Advice, 1908-09, p. 21.

in last year's report(*viii*) gave some promise of being useful. The leaf yields about ·3 per cent. indigotin. Manufacture of the dye carried out on the laboratory scale (all that the then present supply of plant admitted) indicated that about 9 seers of 60 per cent. indigo might be obtained per acre at one cutting. It is a perennial shrub and several cuttings might be expected per season. A difficulty attending its use is the requirement that a relatively high temperature of the steeping water—104° F.—must be maintained for 12 hours. The explanation of the necessity for this temperature was not ascertained.

*Seed supply.*—Although this matter has nothing to do directly with the chemical side of the work, it cannot be left altogether unnoticed. It has transpired that a great deal of indigo seed has been coming from Sukkur. The variety of *I. Sumatrana* grown in the neighbourhood of Sukkur is known to yield a very low quality of plant from the manufacturer's point of view, and its disadvantages are obvious.

*Indigo paste.*—A quantity of indigo was sent to Europe in the form of paste and reported on favourably by dyers. It was also tested at the Cawnpore Woollen Mills and there found to equal the synthetic paste, the two being tested on a basis of equal amounts of indigotin.

*Selection and plant breeding.*—The second part of the Sirseah Report deals with Mr. Parnell's share of the work of the last four years. His problem was to ascertain whether the plant could be improved in respect of its indigo-yielding power by either selection or hybridisation.

A close study of the morphological characters and the indigo yield showed there was no simple correlation, and it followed that the valuation of every plant must depend on its chemical analysis. It is necessary to realise this and also the circumstance that the chemical test in any one case is a somewhat time-absorbing matter, because it explains that the progress of such work must be a slow one. Another controlling factor is the duration of each generation. The Java plant was worked on chiefly because it seemed to offer a better promise of encouraging results. It is sown in September-October; the plant flowers at the same period of the following year and the seed comes ripe in the succeeding February. Thus two years must elapse before the seed of the second generation is planted.

Commencing in 1910, 235 plants were selected and analysed; the seed of these was expected in the following February. Unfortunately inordinately high floods visited Sirseah and the whole of these plants were destroyed. In 1911, 555 plants were analysed; but misfortune again followed; the disease, which has recently taken such a hold of the

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(*viii*) Annual Report, Board of Scientific Advice, 1911-12, p. 30.

indigo plant in Bihar, attacked and killed nearly the whole of these plants.

Whether the proportion of indican in the leaf is chiefly controlled by the inheritance factor is still doubtful, but the curves published in the report show that it is at least possible, and it is much to be regretted that this part of the work should have been brought to a conclusion before it was in the least degree possible to provide an answer to this very important question.

## BETEL VINE LEAVES.

A contribution to the knowledge of the chemistry and physiology of the leaves of the betel vine—*Piper betle*—has been made by Messrs. Mann, Sahasrabuddhe and Patwardhan.(*ix*) Although this leaf is consumed so widely in south-east Asia and universally in India this investigation seems to be the first attempt to ascertain its chemical composition and to detect any characteristic compounds. Leaves were examined from different parts of the vine.

*Sugars.*—Both reducing and non-reducing sugars were found, though not identified; the quantities were 1·5 to 3·0 per cent. of each class; usually there is rather more of the former than of the latter. *Starch* was found in the proportion of approximately 1·0 per cent. *Essential* oils varied only slightly and were present to the extent of about 1·0 to 1·5 per cent. *Tannins* varied from 1·0 to 1·3 per cent. The leaves are slightly acid and contain compounds possessed with diastatic activity, the younger leaves containing the most. *Potassium nitrate* was found in all leaves and also in the stems in comparatively large amount, from 1·0 to 4·0 per cent. of the dry substance, which is a most unusual circumstance in plant life.

*Bleached leaves.*—An adjunct to the betel leaf industry is the bleaching of the leaves, these bleached leaves commanding a price about three times as great as the ordinary green leaf. Curiously this special industry has never been described in English literature and the authors provide this in the memoir. The process is briefly as follows: The fresh green leaves, in quantity about 50—70 lbs. weight, are packed carefully edge downwards in a circular basket, and at the same time are moistened. Periodically at intervals of every few days the leaves are removed and examined; decayed ones are thrown out, bleached ones removed for sale, and green sound leaves replaced. In experiments conducted by the authors, about 50 per cent. of the leaves bleached, and the greater part of the other half were decayed and useless.

During the bleaching it was found that the amount of essential oil increased from 1·0 to about 4·0 or 5·0 per cent.; the acidity also increased;

(*ix*) Memoirs, Department of Agriculture in India, Chemical Series, Vol. III, No. 2.

the starch and non-reducing sugars decreased; the nitrate remained constant. Experiments were made by exposing small numbers of leaves to the action of various vapours and these indicated that the bleaching process is one of oxidation in acid solution; anything in the nature of an alkali causes rotting of the leaf.

## PHYTIN AND PHYTIC ACID.(x)

With a view to a more exact knowledge of the organo-phosphorus compounds in seeds, Mr. G. Clarke has separated phytin and phytic acid from field mustards, and has described them. The ultimate object in view is additional means of bringing the properties of certain seeds into comparison with one another.

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## PART III.—FOREST CHEMISTRY.

BY

PURAN SINGH, F.C.S.,
*Forest Chemist.*

The following is a brief account of the more important work carried out by the Chemical Department of the Forest Research Institute during the year under report:—

**Burma Myrabolans.**—Nineteen samples of Myrabolans collected in different localities in Burma were analysed with the object of comparing their tannin value with that of Myrabolans grown in India. The tannin content of the fruit-pulp was found to vary from 19 to 22 per cent., only two samples showing 34 per cent. Thus the Burmese Myrabolans appear to be 50 per cent. poorer in tannin than those grown in India, the average tannin content of which is about 50 per cent. The Burma Myrabolans also give darker coloured tan liquors which contain four to five times more red and five to six times more yellow than do the liquors prepared from Indian Myrabolans. It is therefore doubtful whether the tree known as *Terminalia Chebula* in Burma is botanically identical with the Indian tree of the same name. The attention of the Forest Botanist has been drawn to this point with the object of deciding the botanical identity of the trees. If they prove to be identical, the factors of the locality, etc., influencing the tannin-content of the fruit will require further investigation.

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(x) Proceedings of the Chemical Society, 1913, Vol. 29.

**Milk of Palaquium Ellipticum,** Benth.—Three samples of the latex were received and the coagulated biscuits of raw gutta prepared therefrom were analysed with the following results:—

| — | No. 1. | No. 2. | No. 3. | Calculated on dry material. | |
|---|---|---|---|---|---|
| | | | | No. 2. | No. 3. |
| Moisture | 0·37 | 23·38 | 19·22 | ... | ... |
| Proteids | 1·90 | 0·27 | 0·24 | 0·35 | 0·30 |
| Insolubles | 4·13 | 5·27 | 4·50 | 6·86 | 5·57 |
| Pure gutta | 31·29 | 21·78 | 27·15 | 28·37 | 33·61 |
| Resins | 62·31 | 49·30 | 48·89 | 64·42 | 60·52 |
| Ash | 0·9 | 2·21 | 1·72 | 2·88 | 1·51 |

The first two of these samples were white and brittle and the last one was reddish in colour. From the above table it will be seen that all these samples of gutta are of inferior quality inasmuch as they contain more than 60 per cent. of resin.

**Boswellia serrata gum resin.**—The enquiry regarding the possible uses of this gum resin is still in progress. Its average composition is:—

| | Per cent. |
|---|---|
| Oil | 8 |
| Resin | 49·63 |
| Gum | 25·99 |
| Moisture | 11·91 |
| Impurities | 4·47 |
| | 100·00 |

A sample of turpentine oil obtained from the resin yielded the following results on fractional distillation:—

| | Per cent. |
|---|---|
| Portion passing below 160° C. | 50 |
| „ „ between 160° C.—167° C. | 17·5 |
| „ „ „ 167° C. and 180° C. | 11·0 |
| „ „ above 180° C. | 21·5 |
| | 100·0 |

These figures indicate a turpentine oil of commercial value. Accordingly a small sample was sent to Messrs. Turner, Morrison & Co., Calcutta, who reported on it favourably as "promising." Preliminary experiments have shown that the distillation of gum resins of this type requires a still of special construction, since in the ordinary stills the gelatinous gum surrounds the particles of resin and thus prevents the full action of the steam. A special still is therefore now being constructed and is expected to be in working order next year.

The resin of this species was chemically examined with the following results:—

| | |
|---|---|
| Specific gravity | 1·8424 at 20° C. |
| Saponification number | 77·33 |
| Acid number | 43·72 |
| Ester number | 33·61 |
| Iodine | 77·49 |

**Tanning materials.**—At the request of various Forest Officers several tanning materials were analysed during the year. A sample of *Terminalia paniculata* bark was found to contain 26·07 per cent. of tannin and 9·45 per cent. of non-tannin. It is thus a rich tanning material and might find a place in the tanning industry. A tannin extract is being prepared from it for further study. Twelve different samples of tan barks and fruits were received from Gwalior State for analysis, but most of these were found to be useless as tanning materials, either because they were too poor in tannin content or because the percentage of non-tannin in them was too high. The best of the samples was *Acacia leucophlœa*. It contained 11 per cent. of tannin and 4 per cent. of non-tannin. *Terminalia Arjuna* contained 12 per cent. of tannin and 8 per cent. of non-tannin and *Zizyphus xylopyrus* from Sipri, 14 per cent. of tannin and 9 per cent. of non-tannin. These are, therefore, tanning materials of average quality. An exceedingly rich tanning material, *Din-gun-the* pods, was received from Burma. It greatly resembles Divi-Divi both in appearance and in tannin value and contains 47·74 per cent. of tannin. The botanical name of this species has not yet been definitely settled.

Two short notes, one on oak bark and the other on the bark of *Terminalia tomentosa* as tanning materials for the manufacture of tannin extracts, have been sent to the *Indian Forester* for publication. It has been shown therein that there is little probability of oak bark being used for tannin extracts in the near future, seeing that an abundance of richer and cheaper tanning materials is available in this country. As regards *Terminalia tomentosa* bark, all attempts to utilize it as a source of tan extracts have hitherto failed, but the enquiry is still being kept open at the Research Institute.

**Sal soils.**—Last year forty different samples of *sál* forest soils were analysed for different Forest Officers. Of these 10 samples were received from the Forest Botanist, 24 from the Divisional Forest Officer, Mandla Division, and 6 from the Divisional Forest Officer, Jalpaiguri Division.

**Sundri fruits.**—These fruits were analysed with a view to discovering some economic use for its starch, either as a famine food or as a source of soluble starch, spirit, etc. The following is the average composition of the fruit:—

| | Per cent. |
|---|---|
| Moisture | 16·85 |
| Tannin | 4·44 |
| Fat | 4·50 |
| Starch | 59·53 |
| Albuminoids | 5·60 |
| Woody fibre, etc. | 6·38 |
| Ash | 2·70 |
| Nitrogen | 8·84 |

Nutrient value:—Albuminoids + starch + starch equivalent of oil (2·3 being the starch equivalent of oil) = 75·48.

Nutrient ratio:—Albuminoids : starch = 1 : 10·63.

It is clear that the fruit may be used as a famine food provided that the tannin is first removed by means of treatment with cold water. The enquiry as to its other possible economic uses is still in progress.

**Ceara rubber.**—The analysis of a thin sheet of Ceara rubber obtained from Coorg and sent by Mr. W. Raitt gave the following percentages:—

| | Per cent. |
|---|---|
| Moisture | 0·85 |
| Proteids | 4·10 |
| Resins | 11·24 |
| Caoutchouc | 82·91 |
| Ash | 0·90 |
| Nitrogen | 6·56 |

This sample was a very clean piece of well prepared rubber and it compares favourably with rubbers grown in Ceylon, East Africa and other places. On account of the high percentage of resin, however, its quality is inferior to that of first grade Ceylon rubber. It is hoped that this defect may be removed by more careful treatment.

**Neem toddy.**—A bottle of the spontaneous exudation of the Neem tree was received from the Conservator of Forests, Gwalior State, and it was analysed by Mr. T. P. Ghose, B.Sc. This toddy is popularly regarded as a remedy for leprosy. The object of the analysis was to

determine its average composition and to locate the active principle. The following is the result of the analysis:—

| | |
|---|---|
| Specific gravity at 18° C. | 1·0589 |
| Angle of rotation at 15° C. | + 11° |
| | Per cent. |
| Moisture | 86·56 |
| Proteids | 0·36 |
| Gums and colouring matter | 6·17 |
| Glucose | 2·99 |
| Sucrose | 3·51 |
| Ash | 0·41 |

The qualitative analysis of the ash showed the presence of the following substances:—

Potassium, iron, aluminium, calcium, and carbon-dioxide.

Only a trace of resinous and fatty matter was obtained and tests for alkaloids and glucosides gave negative results. No active principle therefore could be located.

**Nickel tannates.**—These salts were studied to some extent last year. It has already been reported that under different conditions of precipitation tannates of different nickel contents are obtained. These conditions have been further studied this year and it is found that not more than two salts can be obtained by any change in these conditions. One is obtained when nickel hydroxide, dissolved either in ammonium chloride or ammonium acetate, is added to an excess of tannic acid solution, and the other when tannic acid solution is added to an excess of nickel hydroxide solution. These salts gave on incineration the following percentage of NiO:—

(*i*) The salt precipitated from excess of tannic acid 8·74 per cent.

(*ii*) The salt precipitated from excess of nickel hydroxide solution 28·34 per cent.

These salts were the same as reported last year and the question of their constitution has yet to be settled. The work will probably be taken up again next year.

**Distillation of Khas Khas oil.**—The distillation of Khas Khas grass with a view to determine the variation in oil-content of samples grown in different localities was taken up during the year. Five specimens were examined and in four of these the percentage of oil was found to vary from ·7 to 1; the other specimen was relatively poor and contained only 0·4 per cent. of oil. More specimens are being examined and the enquiry will, it is hoped, be completed next year.

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# ASTRONOMY.

BY

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*Director-General of Observatories.*

**Solar physics.**—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T. Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the

centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disk in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Rowland with $3\frac{1}{4}$-inch ruling is usually employed.

(*d*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during employment of the spectroheliograph and associated instruments.

(*e*) An 8-inch visual achromatic lens from the Maharajah Takhtasinji Observatory, Poona, temporarily mounted in the spectroheliograph room on a pier near the Foucault siderostat. It is used for forming a solar image on the spectrograph slit specially for sunspot work.

(*f*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a $3\frac{1}{3}$-inch concave grating of 10-foot focus mounted on

Rowland's plan. A 2-inch parabolic grating can be substituted for the concave grating, and a collimating lens may be employed with either grating to cure astigmatism.

(*g*) A 6-inch equatorial refractor with large grating spectroscope attached is used for the study of sunspot and prominence spectra and for recording the prominences by visual methods. The equatorial mounting and the spectroscope are from the Maharajah Takhtasinji Observatory, Poona.

(*h*) A 6-inch equatorial refractor by Lerebour and Secretan fitted with a photovisual object glass acquired from the Poona Observatory. The instrument is used for obtaining the daily series of large scale photographs of the sun, and for direct observations.

**Routine work.**—In addition to the daily records obtained by the two spectroheliographs, the routine work includes visual examination of sunspots and faculæ, sunspot spectra, and of bright lines or displaced lines in spots and prominences. The position angles and forms of the prominences are also recorded. A monthly article describing the solar activity is contributed to the "Monthly Weather Review" while for more technical purposes bulletins and memoirs of the Observatory are issued ; of the former 30 have appeared while of the latter the first has been published.

**The distribution of prominences.**—A remarkable peculiarity in the distribution of the prominences has been brought to light from a study of the Kodaikánal records. If the prominences recorded on the east limb are compared with those of the west a numerical preponderance of east over west is found for each year since these observations were begun in 1904. The averages for the past eight years show that for every 100 prominences observed on the west side of the sun's axis 111 were recorded on the east side and this ratio is nearly constant for each of the eight years. This applies to all classes of prominences, but if the special class which is associated with sunspots is treated separately a considerably greater excess of east over west is found. Prominences showing displacements of the spectrum lines indicating violent movement also show a much greater eastern excess than the average of all prominences.

These results appear to show that both prominences and sunspots are more active when near the east limb than when near the west. The numerical preponderance and the increased activity on the east side is very difficult to explain except on the improbable hypothesis that the earth itself affects the distribution and activity of the prominences, and tends to extinguish the smaller prominences during their transit across the sun's visible hemisphere.

The cause, whatever it may be, is evidently connected with that which produces an excess of spots east of the central meridian of the sun, and the above enquiry was suggested by the very remarkable results obtained by Mrs. Maunder in her exhaustive analysis of the Greenwich sunspot records.

**Spectroscopic investigations.**—The large grating spectrograph has been employed in obtaining comparison spectra of the sun's opposite limbs, and of the limbs compared with the centre of the disk. A special reflecting device was constructed and used for photographing two or three spectra from different regions on the sun simultaneously and side by side on the plate. A large number of measures of the displacements of the lines at the sun's limb have been made and in addition numerous determinations of the equatorial speed of rotation of the sun.

The rotation results show systematically smaller velocities than the values obtained in 1906 and 1908 at Mount Wilson Observatory, the differences amounting to from 3 to 7 per cent. They agree, however, within 1 or 2 per cent. with the values obtained in 1911 at Cambridge. It seems possible that this indicates a real change of rotation speed in the sun's absorbing atmosphere, which may vary with the sunspot period, but further research is necessary to determine whether systematic errors affect the measures of different observers. A new method of measuring the plates has been devised which it is hoped may help to clear up this uncertainty.

Comparison spectra have also been obtained of the electric arc and the sun for comparing the wave lengths of the iron and nickel lines in the arc and in the sun. In some of the plates the comparison is with the centre of the sun's disk and in others with the east and west limbs. From the latter independent determinations of the equatorial rotation speed have been obtained and these are in agreement with the determinations from spectra in which the east and west limbs are directly confronted.

The displacements observed when the arc is compared with the centre of the disk are found not to agree with the residual displacements observed when the limb is compared with the centre and the rotation displacement is eliminated ; and there seems to be no clear relation between the amount of displacement for the different lines, either limb *minus* centre or centre *minus* arc, and the displacements due to pressure. It is of great importance to determine whether these small displacements in the solar lines are really due to pressure in the reversing layer as has been assumed hitherto. The above results would seem to throw great doubt on the generally accepted theory.

# METEOROLOGY.

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,
*Director-General of Observatories.*

**Upper air investigations.**—Sanction has been given by Government for a scheme providing three lakhs to be spent in ten years on enquiries into the conditions of the upper air, and Mr. Field has been relieved of his duties at Simla in order to take charge of the work. The head-quarters are to be at Agra, where an observatory is being built and it is proposed to send up instruments twice a week on balloons to as great a height as can be attained. There are to be four or five auxiliary stations where, as also from Agra, instruments will be sent up to lesser heights, say 2 or 3 miles, in order to give information as to the conditions affecting daily weather.

Mr. Field was unfortunately obliged to take leave in August and has not yet returned, so that the initiation of the scheme has been delayed. In the meantime Mr. Harwood, who is to act as his assistant, has been making observations with pilot balloons at Simla and Darjiling, and is working out their results in addition to some previously made.

**General meteorology.**—Owing to shortness of staff at Simla it has only been possible for a very small amount of research work to be done there. Some progress has, however, been made in the examination of seasonal relationships, and it has been shown that in the great majority of cases the storms that give northern India its precipitation in the cold weather have travelled from Europe, being of the same type as those which give Europe rain through the year.

**Publications.**—The customary Daily Weather Reports of Simla, Calcutta, Bombay and Madras, the monthly and annual supplements to the Simla Daily Weather Report, the Monthly Weather Reviews, the Annual Summary, and various administrative pamphlets were issued during the year.

# TERRESTRIAL MAGNETISM.

BY

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*Director-General of Observatories.*

**Magnetic observatories.**—*Bombay (Alibag).*—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city : it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern, a set of sight-reading instruments of Eschenhagen pattern, a Schulze earth-inductor, and ordinary magnetometers and dip-circles. There is also a large declinometer for eye observations, and the old Colaba horizontal force and vertical force magnetographs were in April 1912 transferred to Alibag for use as eye-reading instruments. There is thus a duplicate equipment both for absolute values and for variations.

The instruments have been in good order and under regular observation.

*Dehra Dun, Kodaikánal, Barrackpore and Toungoo.*—These observatories were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained throughout the year. Observations for personal error (*vide* report for 1910-11) are now made periodically at Kodaikánal where the Director, Solar Physics Observatory, has kindly given permission to use the observatory chronograph.

The mean values of the magnetic elements for 1912 at the observatories are as follows :—

| Observatory. | North Lat. and East Long. | Declination. | Horizontal force. | Vertical force. | North dip. |
|---|---|---|---|---|---|
| | | | C. G. S. | C. G. S. | |
| Alibag . . | 18° 38′<br>72° 52′ | E. 0° 51′ 11″ | ·36874 | ·16367 | 23° 54′·8 |
| Dehra Dun . | 30° 10′ 19″<br>78° 3′ 19″ | E. 2° 25′·9 | ·33218 | ·32244 | 44° 8′·9 |
| Barrackpore . | 22° 46′ 29″<br>88° 21′ 39″ | E. 0° 44′·0 | ·37369 | ·22316 | 30° 50′·7 |
| Kodaikánal . | 10° 13′ 50″<br>77° 27′ 46″ | W. 1° 5′·8 | ·37543 | ·02616 | 3° 59′·1 |
| Toungoo . . | 16° 55′ 45″<br>97° 27′ 3″ | E. 0° 13′·4 | ·38889 | ·16548 | 23° 3′·1 |

**Magnetic Survey.**—*Field Operations, 1912-13.*—During the field season, three detachments were employed on field work under the Officer in charge (Captain Thomas, R.E.) and two provincial officers.

The Officer in charge inspected Barrackpore and Toungoo base stations, observed at repeat stations and subsequently carried out a preliminary survey of Ceylon.

The provincial officers were partly employed on detail survey and revision of the work of season 1901-02 and partly on revisiting repeat stations.

Comparative observations were made at the four survey base stations and at Alibag to determine the differences from the survey standard.

During the season full sets of magnetic observations were made at the following :—

58 repeat stations.
19 old stations revised.
42 new stations in Ceylon.
3 new stations in India.
20 detail survey stations in the Central Provinces.

Under repeat stations are included observations at the old field stations which were marked by pillars in 1910-11 ; these number in all 50 which, with the original 23 repeat stations, give 73 repeat stations in all or about 1 to 19 stations of the fundamental survey.

One detachment remained at head-quarters and was employed on the reduction of the declination data of the survey which is nearing completion.

The computing section which remains permanently at head-quarters was engaged on its normal work of computation and tabulation of the base station results.

*Work during recess 1913.*—The reduction and tabulation of the observatory data for 1912 have been completed for five quiet days per month ; the results for " all days " will also shortly be available.

The computation of the field work of 1912-13 is in hand and will be completed before the end of the recess.

The investigation of the instrumental differences in H. F. referred to in the two last reports is nearing completion.

## *List of Publications.*

EVERSHED, J. . . On the presence of radium and the elements of the inactive group in the chromosphere. (*Bulletin No. XXVII.*)

,, ,, . . On the relative numbers of prominences observed on the eastern and western limbs. (*Bulletin No. XXVIII.*)

,, ,, . . Summary of prominence observations for the first half of the year 1912. (*Bulletin No. XXIX.*)

,, ,, . . Summary of prominence observations for the second half of the year 1912. (*Bulletin No. XXX.*)

,, ,, . . Summary of prominence observations for the first half of the year 1913. (*Bulletin No. XXXI.*)

,, ,, . . A new method of estimating changes in the general radiation of the Sun. Read at the International Solar Union at Bonn in August 1913.

,, ,, . . Report on sunspot spectra (a summary of the visual and photographic work done at Kodaikánal during the years 1910, 1911, and 1912). Read at the International Solar Union at Bonn in August 1913.

EVERSHED, J., & ROYDS, T. Some spectroscopic measures of solar rotation. (*Monthly Notices, Astronomical Society.*)

FIELD, J. H., & JACOB, S. M. On the rapid calculation of times of moonrise and moonset. (*Memoirs, Vol. XXI, Part IV.*)

ROYDS, T. . . Prominence periodicities. (*Bulletin No. XXXIII.*)

,, ,, . . The distribution in latitude of dark H markings. (*Monthly Notices, Astronomical Society.*)

ROYDS, T., & S. SITARAMA AIYAR. The determination of ancient dates from astronomical data. (*Astronomical Society of India.*)

WALKER, GILBERT T. Data of heavy rainfall over short periods in India. (*Memoirs, Vol. XXI, Part III.*)

,, ,, . The liability to drought in India as compared with that in other countries. (*Memoirs, Vol. XXI, Part V.*)

,, ,, . Monthly and annual rainfall normals. (*Memoirs, Vol. XXII, Part I.*)

WALKER, GILBERT T., PART I. & HEM RAJ, RAI BAHADUR, PART II. The cold weather storms of Northern India. (*Memoirs, Vol. XXI, Part VII.*)

# GEOLOGY.

BY

H. H. HAYDEN, C.I.E.,
*Director, Geological Survey of India.*

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## MINERALOGY AND PETROLOGY.

**1. White pyroxene rock: tremolite: bowenite.**—Mr. Middlemiss has described some interesting mineral occurrences from the Aravallis of Idar State. At Bamanvada (lat. 23° 36′; long. 73° 20′) massive, white pyroxene rock is found associated with crystalline limestone and quartz-pyroxene schist, the whole series being intercalated as a band, 50 to 60 feet thick among mica schists. The coarsely crystalline, often pure white, pyroxene is found in beds of from a few feet to as much as 30 feet thick at one place, and may be traced at intervals for many miles. Although pyroxene as a constituent of many igneous rocks is common, this is the first instance recorded of extensive beds of the pure mineral having been found in India. Its optical and chemical characteristics are those of the diopside group of monoclinic pyroxenes, and it suffers local changes into white or pale green tremolite or actinolite in radiating tufts and interlaced fibres. Some of the latter layers are rather compact and semi-translucent, but not sufficiently so to have any value as jade (nephrite) as at present explored, though the occur-

rence is suggestive. The white pyroxene rock mottled here and there by the pale green tremolite makes a tough and handsome ornamental stone when polished.

2. At Bhetali, seven miles along the outcrop from Bamanvada, a grey mottled variety appears with graphite in nests and films round and among the pyroxene crystals. Some of the associated crystalline limestone at Bamanvada shows small patches of hard dark green serpentine (bowenite) resembling in a small way that from the Safed Koh described by McMahon (*Min. Mag.*, Vol. IX, p. 187, 1890). Mr. Middlemiss concludes from the lie and associations of this band of rocks that they are mainly the result of contract-metamorphism induced by dykes of olivine-gabbro and dolerite which penetrate the series.

3. **Idocrase.**—Mr. Middlemiss has further recorded massive idocrase (vesuvianite) from near Nadri (lat. 24° 0′; long. 73° 2′). This mineral does not seem to have been much more than mentioned before in India, with the exception of that from Tonk referred to by Mallet (*Man. Geol. of India*, pt. 4, *Mineralogy*, p. 93). Mr. Vredenburg doubtfully recognised it in some Idar granite collected by Professor Page, a point which so far Mr. Middlemiss has not been able to verify. The present occurrence is in metamorphic Aravalli limestones, which in the neighbourhood are modified by intrusive veins of granite and aplite into a rock composed of calcite, quartz, microcline, diopside, wollastonite, etc., and secondly into the rock now described, by further intrusion into them of the latter bosses of Idar granite. The rock is coarsely crystalline, with large shining cleavage plates of poikilitically developed idocrase among and including the other normal constituents of the calc-gneiss. The bands are several inches across, the proportion of the mineral to the rest of the rock being about 5 to 1. The determination is based on physical and optical tests, no chemical examination having yet been made.

4. **Teng-yueh volcanics.**—Mr. R. C. Burton has examined and described a series of volcanic rocks collected by Mr. Coggin Brown in the neighbourhood of Teng-yueh. These consist of three groups:—

(*a*) pyroxene-andesites;

(*b*) hornblende-andesites, pyroxene-andesites, with augite-olivine andesites and olivine basalt;

(*c*) olivine basalts.

These sub-divisions correspond with the three groups respectively termed by Mr. Brown "bedded andesites," "massive andesites" and "basalt lavas of Tay-in-shan," and are enumerated in order or age, the first being the oldest. The rocks of group (*a*) are very much older than those of group (*b*), which are of pliocene and pleistocene age, some

of the lavas, as for example those of the now extinct She-toe-shan crater, being of recent age.

5. In general characteristics the andesites and basalts described by Mr. Burton are similar to those of the younger Burmese volcanoes, the lava of Ho-shuen-shan being comparable to the late Tertiary basalts of the Northern Shan States. A specimen of augite andesite from Kan-lan-ssu contains a considerable amount of brown glass resembling the palagonite of the Rajmahal trap.

6. **A suggested infra-plutonic zone in the earth.**—An interesting paper read by Dr. Fermor before the Asiatic Society of Bengal (*Journ. A. S. B.*, Vol. VIII, No. 9, p. 315) led him to the consideration of the conditions existing below the surface of the earth, from which he has deduced the presence, below the plutonic zone, of a belt of material under high pressure and containing garnet as a typical constituent; this he terms the infra-plutonic zone (*Rec., Geol. Surv. India*, Vol. XLIII, p. 41). Although admittedly of a somewhat speculative nature, the views put forward by Dr. Fermor are of great interest and highly suggestive; his memoir on the subject when published will undoubtedly form a very important contribution to the study of the chemical and physical constitution of the earth.

## PALÆONTOLOGY.

7. **Tertiary mammals in the British Museum.**—During his absence on study leave Dr. Pilgrim examined most of the types of mammalia now in the British Museum from the Upper Siwaliks of the Siwalik Hills, as also from Perim Island and Burma. These have been described partly by Falconer and partly by Lydekker, and there are very few duplicates in the Geological Museum in Calcuttta. Dr. Pilgrim also examined the fine collection of Pikermi species in the British Museum for purposes of comparison with our Middle Siwalik fauna. At the same time he worked out and described a small collection of *Carnivora* from the Lower Siwaliks of Chinji and also from the Middle Siwaliks. This work will, it is hoped, serve as a nucleus for a more extensive revision of the Siwalik *Carnivora* to be undertaken subsequently. Another group examined by Dr. Pilgrim was the *Mastodontidæ*, which he found to be also in need of revision.

8. Mr. Swinhoe's collection of mammals, which is in the British Museum, was also examined. The specimens are from two localities, namely, (1) the right bank of the Irrawadi opposite Mandalay and (2) near Yenangyaung. The collection from the former locality was found to include *Elephas antiquus* (*namadicus*) and is therefore presumably of pleistocene age. Among the specimens from near Yenangyaung Dr. Pilgrim found a new species of *Merycopotamus*, of which, with

Dr. Smith Woodward's consent, he has written a description. Other interesting specimens noticed were a skull from Perim Island attributed by Lydekker to the genus *Strepsiceros*. Dr. Pilgrim on developing this specimen to a considerably greater extent than had formerly been done, found the generic attribution no longer tenable and regards the skull as representing a new genus.

9. Another interesting skull which had apparently been overlooked for some years bears a label containing the word "Ava." If the specimen really came from Ava its age is presumably Middle Siwalik, since numerous Middle Siwalik species have been obtained from that locality. If this is so, its presence is interesting, since Dr. Pilgrim regards it as undoubtedly an ancestral form of the Pliocene *Leptobos*. He also found that it possessed decided antelopine affinities. In view of the interest attaching to it Dr. Pilgrim wrote a description of the specimen with Dr. Smith Woodward's permission.

10. A fine collection of *Hipparion* skulls from Pikermi also proved of considerable interest, being found to comprise two species, namely, the pontian form *H. gracile* and also another which Dr. Pilgrim regards as almost, if not quite, identical with the Indian form *H. punjabiense*, from the Middle Siwaliks of the Salt Range.

11. **Tertiary mammals at Basle.**—Dr. Pilgrim also paid a visit to Basle where Professor Stehlin very kindly allowed him to examine numerous specimens which proved to be interesting and useful for purposes of comparison with Siwalik forms.

12. **Tertiary Mollusca of Sind and Baluchistan.**—Mr. Vredenburg was also absent on study leave during the year and examined collections of Tertiary invertebrate fossils both in England and on the Continent, for purposes of comparison with the Tertiary fossils of Sind and Baluchistan, on a description of which he has been engaged for some years past. His work comprises two main sections, firstly, the revision of the Sind Tertiary types of D'Archiac and Haime, and secondly, a complete description of the post-eocene Tertiary molluscan fauna of North-Western India. D'Archiac and Haime's types have been carefully revised and their geological horizons ascertained. Most of the mollusca proved to be from the Gaj and Lakhi stages, the Gaj being chiefly represented and the fossils from it as a rule well preserved, whereas the specimens from the Lakhi stage were usually casts. There are also a few Ranikot forms, very few from the Nari, none from the Khirthar, and only one from the Cretaceous. The post-eocene mollusca that have been described by Mr. Vredenburg comprise over 350 species of which about 120 are new. Mr. Vredenburg finds that the only forms that show any close relationship to European species are those from the Nari, whereas the percentage becomes very small in the Gaj beds and

still smaller, practically none, in the Hinglaj, the fossils of which latter stage are closely related to those of Java.

13. **Jurassic ammonites.**—Before taking leave Mr. Tipper was engaged on the description of the Jurassic fossils from Baluchistan on which he has been engaged for some years. He has made considerable progress in the work and it is hoped that his results will soon be ready for publication.

14. **Palæontological work being done in Europe.**—The Cretaceous fossils collected by me at Kampa dzong and Tuna in Tibet and the Jurassic brachiopods collected by Messrs. La Touche and Datta in the Shan States are still in the hands of Professor Douvillé and Mr. S. S. Buckman respectively.

15. Collections of Palæozoic fossils made by Mr. Griesbach in N. W. Afghanistan and Khorasan and by me in the Koh-i-Baba have been examined and described by Miss Colley March, B.Sc., of Manchester University. Mr. Griesbach's collections contain well-preserved brachiopods, the best having been obtained from Robat-i-pai near Herat; they include species of *Spirifer* (cf. *bisulcatus* and cf. *clathratus*), *Productus* (*semireticulatus* and *pustulosus*), *Camarophoria* cf. *purdoni* and *Atrypa aspera*. Miss March regards these fossils as essentially Lower Carboniferous, and ascribes the presence of *Atrypa aspera* to a local survival of this species beyond the usual Devonian limit; experience of the difficulties under which specimens are collected during expeditions of the kind on which Mr. Griesbach was engaged at the time, would dispose me rather to infer that he had not had an opportunity of working out horizons in detail and consequently did not suspect the presence of more than one system; it is clear from his lists that fossils collected from beds some little vertical distance apart were not differentiated, and the collection might thus easily contain both Lower Carboniferous and Upper Devonian species. The close association of fossils belonging to these two systems near the Kotal-i-Hajigak in the Koh-i-Baba lends considerable colour to this explanation.

16. Miss March has also described the fossils collected by me from the upper beds of the Hajigak limestone; they are badly preserved, but were found to include *Spirifer wynnei*, *Chonetes* cf. *hardrensis*, (?) *Phillipsia derbiensis*, a new species of *Streblodus* named by Miss March *Str. incurvus*, and several species of *Zaphrentis* and *Syringopora*. The most striking feature of all these fossils is, according to Miss March, their close affinity to European forms. Their age is regarded as Lower Carboniferous.

17. A description of the lamellibranchs of the Ranikot stage by Messrs. Cossmann and Pissarro has been received and will shortly be published.

18. During the year, Professor Seward completed his examination and description of the Gondwana plants collected by Mr. Middlemiss on the Golabgarh pass. These include *Glossopteris indica* Schimp and *Cordaites hislopi* Bunb., both typical species of the Lower Gondwanas of the peninsula; they thus furnish unequivocal evidence of the identity of the Gondwanas of Kashmir with those of the coal-fields of India. Professor Seward's memoir has been published in the *Palæontologia Indica.*

## ECONOMIC ENQUIRIES.

### Building Stones.

19. The limestone of which the Simla town-hall is built was submitted to the Geological Survey for examination and report. It was said to have been obtained from the quarries on Prospect Hill and was found to be very friable and impure, and not suitable for building purposes. Specimens of the Sanjauli quartzite were also examined and found to be excellent building-stones.

### Coal.

20. **Raniganj coal-field.**—The re-survey of the Raniganj coal-field and revision of the map originally prepared by the late Dr. Blandford, on which Mr. Walker was engaged on behalf of the Mining and Geological Institute, in co-operation with a committee of the members of that body, was completed during the year. Mr. Walker's report on the correlation of the seams has also been handed over to the Institute by which it will be published.

21. **Coal in Korea State, Central Provinces.**—Attention having recently been drawn to the possibility of exploiting profitably the coal-fields in the Korea State of the Central Provinces originally examined by Mr. Hughes (*Memoirs, Geol. Surv. India,* XXI, pt. 3), the Chief Commissioner has asked that a member of the Geological Survey should make a more detailed examination of the area. The matter has therefore been taken up by the Central Provinces party and Dr. L. L. Fermor proceeded to Korea at the end of the year. Having only just arrived on the field at the conclusion of the period covered by this report, his results are not yet available. Samples of coal, however, were sent for assay to this Department in September 1912, by the Political Agent, Chhatisgarh Feudatory States; these proved to be of fair quality, the percentage of ash being about 6; the percentage of moisture is undesirably high and varies from 7 to 10 per cent.; the calorific value of the better samples ranged between 6,650 and 6,850. The localities from which the best samples were obtained are Kouraia nala, Kurasia and Kukri nala.

## Engineering Questions.

22. **Darjiling landslips.**—In pursuance of the recommendations of the Landslip Committee which met in Darjiling in October 1911, Dr. L. L. Fermor was employed during the summer of 1912 in making a detailed geological survey of the Happy Valley and neighbouring hill-sides. Through the courtesy of Lt.-Colonel R. T. Crichton, C.I.E., Director of Surveys, Bengal, he was provided with large contoured maps. Dr. Fermor's more extensive survey has, while greatly amplifying them, tended to confirm the results arrived at by the committee. His recommendations and conclusions have been forwarded to the Government of Bengal.

23. **Dharmsala hill slopes.**—The conditions of the hill slopes at Dharmsala having given cause for apprehension lest landslips might occur, a committee was appointed to examine the station and report to the Local Government. The services of a member of the Geological Survey having been asked for in this connection, Mr. C. S. Middlemiss joined the committee on his way back from field-work in Kashmir at the end of the monsoon season. Having visited Dharmsala in 1905 in the course of his investigation of the effects of the great earthquake of April 4th, his intimate knowledge of the geological conditions rendered Mr. Middlemiss peculiarly suitable for this further investigation. His conclusions, which were submitted with the report of the committee, tend to show that there is no immediate danger to be apprehended so long as certain necessary precautions be taken without delay. These include the afforestation of bare hill-sides and the closing to grazing and wood-cutting of those already partially deforested; in addition to this certain measures are recommended with regard to rendering the water channels and the drainage system more efficient.

## Gold.

24. **Burma.**—Mr. H. S. Bion was deputed at the beginning of the field-season of 1912-13 to take up the examination of the auriferous gravels of the Chindwin river. His work only covers a short period during the year under review, and comprised chiefly an inspection of the gravels at the small gold-washing villages of Manlaikgyi and Manlaikgale, seven miles below Kindat; these were found to be valueless. The gravel island opposite Helaw was also examined and the gold content found to be very irregularly distributed. The surface gravels, which are quite rich in places (carrying from 8 to 15 grains per cubic yard), are barren in others. Only the surface is rich, there being practically no gold at a depth of four feet. Traces of platinum also were met with.

## Iron.

25. **Goa and Ratnagiri.**—In March 1912, Dr. Fermor visited the iron-ore deposits of Goa and Ratnagiri, where the Compagnie des Mines de Fer de Goa and Messrs. Jambon & Co. respectively gave him every facility to inspect their properties. In Goa, the iron-ore occurs in beds of the Dharwar system, and the total amount is believed to be very considerable. In the southern parts of Ratnagiri and in the adjoining State of Savantvadi, similar geological conditions prevail, and deposits of iron-ore have been found, at Redi in Ratnagiri and near Banda in Savantvadi. It is considered probable that before long an export trade may be developed from this part of India.

26. **Jaipur State.**—Mr. Heron records the presence of large quantities of hematite in the Raialo marbles near Raialo and Nimla. He attributes these deposits to metasomatic replacement of the calcite by iron-bearing solutions. Whenever a hillock is seen in the Raialo marble, it is found to be due to the superior resistance to denudation of these masses, which stand out as dark-coloured piles of rock from the level stony plain of yellow or pale brown weathered marble. The rock varies, according to the amount of replacement, from marble stained brown by iron, to nearly pure hematite. The deposits are elongated more or less in the direction of the strike, but thicken and thin out in a quite irregular fashion; they are, in fact, lines of irregular lenticular masses rather than bands. It is difficult to estimate their real thickness, as the slopes are covered with boulders which are strewn to a great distance around and quite obscure the rocks beneath, giving an appearance of thickness greater than is really the case. Bands up to seven or eight feet across of pure hematite, were measured, and there are many much wider. If thin calcareous bands, which would be mined along with the ore and eliminated by hand-picking, are included, the width must run to many yards, and the amount of ore is certainly very great. The locality is situated about 15 miles from Dosa railway station, the intervening country presenting no impediment to railway and tramway construction. Extensive old workings are also seen near Nimla and between Raialo and Kalajpuri; these probably supplied part of the raw material for the now extinct iron industry of Bhangarh.

## Kaolin.

27. **Jaipur State.**—Mr. Heron records the presence in Jaipur State of deposits of kaolin which may possibly be of value. $1\frac{1}{4}$ mile S. E. of Rasnu (26° 41′; 76° 37′) a long and spacious tunnel has been driven along the strike of a bed of kaolin which runs midway in the ridge of Alwar quartzites and is about 20 yards wide, white but rather impure, banded with quartzite. There is evidently a very large quantity available.

It has been quarried for local uses only, such as white-washing, etc. Kaolin is also dug from the soft argillaceous and talcose zone near the base of the Alwars at the north end of the Lalso hills, chiefly near Daraoli (26° 55′; 76° 58′). There are two beds separated by quartzite; the upper one provides a white and fairly pure clay, slightly mottled with pale purple and pink.

## Petroleum.

28. **Assam.**—Mr. Pascoe completed his examination of the petroliferous localities of Assam and prepared a memoir which is now in process of publication.

29. **Burma.**—During the early part of the year, Mr. Cotter was on duty at the Yenangyaung oilfield, where he was succeeded by Mr. Coggin Brown. Owing, however, to his health giving way, the latter officer was relieved in July by Mr. Heron, who remained at Yenangyaung until the beginning of the field-season of 1912-13.

30. Sub-Assistant Sethu Rama Rau describes petroliferous areas at Yeyodaung and 3 miles N. N. W. of Nga-hlain-dwin in Minbu district. At the former locality, where a Burmese well has been dug, the beds at the crest of the anticline dip at low angles of from 10° to 12°. There are also a few Burmese wells at the second locality, and both places are regarded as being probably of economic value. The oil is said to occur in the upper beds of the eocene series.

31. **Punjab and North-West Frontier Province.**—Having completed his work in Assam, Mr. Pascoe proceeded to examine the petroliferous localities of the Punjab and North-West Frontier Province, and was still engaged on this work when an attack of suspected enteric compelled him to return to hospital at Lahore. His results are not therefore available yet.

## Potash Salts.

32. **Salt Range.**—Dr. W. A. K. Christie was deputed in January to the Salt Range in the Jhelum District of the Punjab to investigate the potash salts found in his previous prospecting operations in the rock-salt mines at Khewra and Nurpur, worked by the Department of Northern India Salt Revenue. The potash beds found in the Mayo Mine at Khewra are generally overlain by seams of unsaleable marl, and their investigation is rendered difficult because the mining authorities, being mainly concerned with the extraction of marketable salt, which exists in unlimited quantities, naturally change the sphere of their operations as soon as a marl seam is struck and before the deposit underlying it is exposed. The principal potash-bearing bed found in the Pharwala section of the Mayo Mine was traced at various points for some 850 feet

along its strike; and over 250 feet with the dip, which is about N. 30° W., with an inclination of 20 to 50°. Its average thickness is six feet and the potash content varies from 6·8 to 9·6 per cent of $K_2O$. The distances given are indications of the comparatively extensive nature of the deposit, but they are not intended as a basis for calculation of the material available for extraction, as questions of expediency in pillar preservation completed the issue. Another seam eight feet thick and carrying 7·7 per cent of $K_2O$ was found in a prospecting drift in the Pharwala salt,—what was presumably the same bed being struck in another prospecting drift 700 feet to the E. N. E. In the Buggy section of the Mayo Mine the only seam of any importance that was found was traced for about 150 feet along its strike, which is E. N. E.—W. S. W. The dip of the bed is about 35°, its average thickness two feet nine inches, and it carries 14·4 per cent of $K_2O$. The seam thins out when followed upwards along the bedding; in another chamber, at a distance of 170 feet south from the nearest exposure, it was found to be only a few inches thick. The seam in the Nurpur mine is exposed only in one place which is difficult of access. It dips S. S. E. at about 75° and at this point is six feet thick. A typical specimen from this deposit carried 14·1 per cent of $K_2O$.

33. The potassium-bearing minerals of the salt formation are chiefly langbeinite and sylvin, kainite and blödite with a small percentage of potassium being often present in small quantities. The deposits are usually fine-grained mixtures of these minerals with common salt and kieserite. The economic bearing of the occurrences, together with questions of their mineralogy and genesis, will be discussed in a paper now under preparation.

## Steatite.

34. **Jaipur State.**—In addition to the locality of Morra long known for its steatite, Mr. Heron describes other and hitherto unrecorded localities where that mineral is extensively developed in thick beds of great purity. The new localities are Dogetha (Dagota), $2\frac{1}{4}$ miles N. E. of Raialo (lat. 27° 5′; long. 76° 15′), Gisgarh (lat. 26° 53′; long. 76° 40′), and Kawa (lat. 26° 46′; long. 76° 32′). The Dogetha deposit is excavated to a width of about 30 yards, but is probably wider, as the country rock on either side is not laid bare. It runs diagonally, dipping at 80° west by south, across the end of a hill and is only excavated for some 50 or 60 yards along the length of the bed in an open cutting. The steatite is very pure, milk-white or faintly tinged with green, with very thin films of pink ferruginous matter in some of the joints. The joints are irregular and allow of pieces up to one foot or so in length being extracted, but most of the material is in much smaller pieces and

no particular effort is made to get large blocks. The deposit is quite structureless except for the jointing, and no clue could be obtained as to its origin; in no place was a junction with the surrounding rock seen. The cost of excavation is about one rupee for six or seven maunds. It is transported to Dosa station on pack bullocks at two annas per maund. Rs. 3,000 is said to be the annual rent paid for the quarry. From Dosa it is sent mainly to Amritsar and some to Cawnpore.

At Gisgarh the bed is only 2 feet thick and the material inferior to that of Dogetha. At Kawa only traces of steatite were noticed in a well.

With regard to Morra-bhandari, the original locality described by Hacket as the source of the stone used by the Agra stonecarvers, Mr. Heron describes the deposit as extending for 5 miles in the form of richer pockets in a stratum concentrated from talcose schist. One of these is mentioned as being about 25 feet thick. Work is only being done at one place 1 mile west of Morra (lat. 26° 49′; long. 76° 51′).

## Water.

35. **Itarsi.**—At the request of the Railway Board, Mr. H. C. Jones visited Itarsi in June, on behalf of the Great Indian Peninsula Railway, in order to report on a proposed scheme for a reservoir. The site chosen for the dam proved unsuitable owing to the porosity of all the rocks in the neighbourhood and no suitable site could be obtained.

36. **Rajdaha, Manbhum district.**—In December I paid a short visit to Rajdaha near Topchanchi in Manbhum district, to examine a site for a dam in connection with an important project for a water-supply for the Jherriah coal-field. It is proposed to build a dam across a small valley immediately below the village of Rajdaha and thus to impound a large body of water. The site for the dam had been chosen where a belt of hornblende-gneiss crosses the valley; this appeared to offer a suitable foundation.

## Wolfram.

37. **Tavoy.**—Mr. Page continued his investigations into the condition of the wolfram industry in Mergui and Tavoy. The absence of reliable maps has led to serious difficulties in the matter of granting licenses and leases and Mr. Page's work has been largely of a clerical nature with a view to preventing the confusion that inevitably follows the failure on the part of applicants to define exactly the boundaries of the concessions for which they apply. Mr. Page is preparing an *ad interim* report and it is hoped that by the end of the present field-season he will be in a position to make final recommendations.

## GEOLOGICAL SURVEYS

### Bombay, Central India and Rajputana.

38. **Mr. C. S. Middlemiss: Idar State.**—Mr. Middlemiss continued his survey in Idar State, begun the previous season, and completed all the main portion of that State, so far as areas of solid geology are concerned, with the exception of a few strips and corners along the north and east boundaries which will be finished off later in conjunction with other outlying parts of Mahi Kantha Agency. The area is included in the following sheets of the 1″=1 mile Bombay Survey (the numbers in brackets refer to the same sheets numbered according to the Central India and Rajputana Survey):—Nos. 119, 143 (120), 144 (121), 145 (122), 146 (123) and 179 (150).

39. The mapping of the calc-gneisses of the Aravalli system, mentioned in the preceding annual report, was continued north of last year's area into the long strip of Idar territory lying between Udepur on the east and Danta on the west. There, in the neighbourhood of Kherod (lat. 24° 14′; long. 73° 3′) an important modification takes place. Instead of being composed as in the Vadali neighbourhood of calcite, quartz, microcline, diopside, wollastonite, scapolite, etc., profusely penetrated by aplite and pegmatite veins, it takes the form of a dark rock composed mainly of crystalline calcite penetrated on a very minute scale by *lit-par-lit* layers of basic hornblende-felspar material (amphibolite), the resulting complex being a precise reproduction in some of its varieties of the amphibolites described by Adams and Barlow in Canada.* This series, which may be called the Kherod amphibolite series, is folded along with garnetiferous mica-schists and phyllites, and seems to underlie to the west the ordinary calc-gneisses of the Vadali area. The full examination of these rocks is still incomplete in the direction of Posina.

40. Other modifications of the calc-gneiss series, with the production of massive idocrase at one locality, and thick beds of white pyroxene and other rocks at another, are referred to in more detail in a separate part of this report (*supra*, paras. 1—3); whilst the steatite, absestos and associated serpentine, magnesite, etc., of Kundol have already been noticed in the preceding annual report and in a short article by Mr. Middlemiss published in the *Records of the Geological Survey of India*, (Vol. XLII, p. 52).

41. Several instructive examples, demonstrating the later intrusion of the Idar granite masses across the sharply truncated edges of the Aravallis with their included older granite veins, were specially noted this

* Geol. of Haliburton and Bancroft areas, Ontario, Dept. of Mines, Geol. Surv. Branch, Mem. No. 6 (1910), pp. 157—172.

season, one being at the N. W. edge of the Dharol hill (lat. 24° 0′; long. 73° 2′) and another at Asai hill (lat. 23° 55′; long. 73° 3′). A few new types were noted among the older aplites and granite veins, one of which is a medium-grained granite with allanite in crystalline grains completely taking the place of the usual ferromagnesian constituents.

42. The exact lie of the Aravalli complex with reference to the succeeding Delhi quartzite is generally not very clear in Idar State, but at one locality near Khercha (lat. 23° 40′; long. 73° 24′) observed last season, the wandering strike directions of the former show complete discordance against and beneath the presumably younger massive Delhi quartzite. The latter itself, whilst building all the rather lofty and sturdy hill ranges, of this part of the country, is also most intricately involved in foldings, twistings and crushings, whose complexity is such as to render any exact reproduction of them in section very difficult; the outcrop and strike are generally self-evident, but evidence of dip in these rocks is not often reliable.

43. The Delhi quartzite again in turn appears to be succeeded on its eastern border by an extensive younger series of soft, thin-bedded and splintery schists or phyllites, of pale drab, yellowish and greenish colours, quite distinct from the Aravallis, and unlike them pierced by no plutonic intrusives, but only by numerous white quartz veins. These build a third type of country, distinct, on the one hand, from that of the alluvium-covered Aravallis, and on the other, from the massive ridges of Delhi quartzite. It consists of long, low, undulating hills with ribs of vein quartz, the whole making a confused, labyrinthine tract of low knolls and intricate stream-beds, the favourite haunt of the Bhils. In its further extension to the east, this series of phyllites merges into those of Dungarpur State east of Isri and Meghraj, where their survey is still awaiting completion.

44. **Mr. H. C. Jones: Gwalior and Tonk.**—Mr. Jones, continuing his survey of last year in Gwalior, proceeded to the southern part of the main area of that State which lies north-east of Bhilsa town (lat. 23° 31′; long. 77° 52′), and is contained in the 1″=1 mile standard sheets, Nos. 374, 375, 376, 392, 393, and 394 of the Central India and Rajputana Topographical Survey. Only towards the end of the season, in March, was he able to continue his survey still further north into a portion of Tonk State adjoining the Bhilsa district. The area surveyed, on its south-west border, marches with that already mapped in detail, partly by E. Vredenburg (season 1897-98) and partly by C. S. Middlemiss, H. Walker and Sethu Rama Rau (season 1904-05). The great diversity of Upper Vindhyan rock stages, from Lower Kaimur sandstone to Upper Bhander, so well exposed in that completed area, was not found, however, to continue into the ground surveyed by Mr. Jones, and

which is now under review. The latter proved to be mainly Deccan Trap and alluvium, with here and there groups of isolated tabular hills composed solely of one or two members of the Upper Vindhyan sequence, namely, false-bedded, purple and mottled sandstone, judged to be of Lower Bhander horizon, underlain locally, as at Udepur (lat. 23° 54′; long. 78° 5′) by greenish and purple shales presumed to be the Ganurgarh shales, and at one place, namely, three miles south-west of Hydergarh Basoda (lat. 23° 37′; long. 28° 14′), by a limited exposure of siliceous limestones. On account of the entirely detached, inlying character of the exposures, surrounded as they are on all sides by wide expanses of Deccan Trap and alluvial valleys, Mr. Jones cannot be absolutely certain of the exact horizons of these rocks (some of which may possibly belong to the Rewa stage).

45. The country, which is a moderately level plain, lies at a general elevation of about 1,800 feet, diversified by isolated hills and hill ranges rising another 400 feet above that. These latter are mostly the sandstone as described above, generally horizontal, but dipping 2° or 3° north-west in the south-west part of the area, and dipping east near Udepur (23° 54′; 78° 5′). The Deccan Trap presents no new features and consists of superposed sheets of dark, fine-grained basalt without olivine and with amygdaloidal layers and interrupted rarely by a very thin and often disrupted bed of Intertrappean limestone and chart, which sometimes becomes a mere collection of residual blocks. No fossils were yielded by these Intertrappeans.

46. Ferruginous laterite and residual laterite lie in frequent but discontinuous patches, especially in the north-west parts of the area. Some fragments of an aluminous variety were noted near Hura (Saugor district). Good cotton soil covers most of the flatter parts, especially those in the north of Bhilsa district.

47. **Economic.**—Nothing of special economic importance is reported. Excellent building and flag stones are of course obtained from the Vindhyans. Ferruginous laterite, once a source of iron, is now largely used as road metal.

48. **Mr. A. M. Heron: Jaipur State.**—Mr. Heron, having in previous years surveyed in detail Alwar State and the neighbouring geologically connected areas to the east, turned his attention during the last working season to the part of Jaipur State lying to the south and south-west of his original base of operations in Alwar. The area surveyed, besides a large portion of Jaipur, includes also the Tonk Pargana of Tonk State, the Chiefship of Lawa and certain detached villages of Bundi State (the Bundi and Lawa areas being completely enclosed by Jaipur territory). This large area is comprised within eighteen standard (1″ = 1 mile) sheets of the Central India and Rajputana

Survey, namely, Nos. 229 to 232, 260 to 265, 288 to 292 and 316 to 318. Of these sheets Nos. 261 to 263, 289 to 292 and 316 to 317 have been completely surveyed geologically, and 264, 265 and 318 finished so far as Jaipur State is concerned.

49. The area, like that previously revised by Mr. Heron, had already over thirty years ago been surveyed by Hacket, and the geology and economic resources outlined in several publications by that author.* Its re-survey was necessary, in continuation of the regular revision of Hacket's work in this area, for reasons explained in previous General Reports. Excluding sheets 288 and 316, mapped in previous years, the rest of the area stretching to the south and south-west is a vast alluvial and sandy plain with only very occasional, narrow, strike-ridges (*mala*) and stripes and patches of rock with north-east—south-west alignments, rising out of that plain. Of these the Lalsot-Toda Bhim elongated ridge-mass stretches for over 40 miles in length, and has been mapped by Mr. Heron as "Delhi system," but described in his report as the Alwar series. Others again, stretching for even longer distances, and sometimes extremely attenuated, expose only the metamorphic Aravallis, with small areas of intrusive granite, pegmatite and quartz veins. In this newly surveyed region, outside sheet 288, none of the lower members of the Delhi system, namely, the Raialo quartzite and limestone, which come normally below the Alwars, have been recognised. Similarly, none of the series above the Alwar quartzite, namely, the Ajabgarh series and Hornstone Breccia, have been certainly detected. Thus the Delhi system is here restricted so far as outcrops are concerned to its middle member, namely, the Alwar or Delhi quartzite series; but it is possible that the other lower and upper members may lie hidden beneath the alluvium.

50. Having revisited the old area of the Raialos, Mr. Heron finally rejects the tentatively expressed idea that the granite is intrusive into them, and now believes them to lie unconformably upon it. It seems now established, therefore, that the Delhi system lies unconformably above the Aravallis and above their intrusive massive granites, though certain pegmatite veins cut through all the systems including, though rarely, the Ajabgarhs.

51. Mr. Heron's report enters very clearly and fully into the description of the new areas. The metamorphic origin of the Aravallis is amply demonstrated by the varying amounts of alteration of them from hardened, though uncleaved, shales to coarsely crystalline biotite schists with staurolite or garnet in great quantity. The dark, impure, thin-bedded quartzites associated with them are deemed to be quite different from the Alwar quartzites (though sometimes marked as such by Hacket) and never like the latter showing ripple-marks. Strictly subordinate

*Rec. Geol. Surv India, Vol. X, pt. 2 (1887), Vol. XIII, pt. 4 (1880), and Vol. XIV, pt. 4 (1881).

to the above are schistose conglomerates, grits and impure argillaceous limestones and epidiorites, of uncertain origin. The general dip is north-west at high angles of from 30° to vertical. The rocks intrusive in these are quartz veins with a small amount of tourmaline, bosses of granite, slightly pressure-foliated, medium-grained and porphyritic, with a groundmass of microcline and a micrographic intergrowth of quartz and felspar; aplite veins; and pegmatites in masses of all sizes from half an inch to many yards across and of medium to extremely coarse grain, their mineral constitution only differing from that of the granites by the presence of tourmaline. The Alwar quartzite representatives of the Delhi system are caught up among the Aravallis in a double or triple set of synclinal folds combined with anticlines by rapid variation in the pitch of the axes, and some of them resemble more nearly those of the Biana Hills (described last year) than those of Alwar.

52. Only one doubtful occurrence of a black brecciated slate near Podampura (lat. 26° 51′; long. 76° 49′) may represent the Ajabgarh series. The rest of the country is a vast expanse of light loam and sand hills, the latter heaped up by the prevailing winds on the western faces of the rocky ridges, but not much resembling the travelling dunes of more desert-like areas, inasmuch as they all bear a scanty vegetation of tall "munj" grass and various small shrubs.

53. **Economic.**—In addition to iron, kaolin and steatite (see paras. 26, 34), Mr. Heron records some trifling occurrences of mica; quartz is also referred to and the garnet workings long since closed, at Toda Rai Singh and other villages to the south and west of Rajmahal.

54. **Mr. N. D. Daru: Dungarpur.**—The survey of the State of Dungarpur was continued by Mr. Daru, who attributes most of the rocks met with to the Aravalli system, the chief types include ortho-gneisses, schists, phyllites, quartzites, boulder-beds and crystalline limestones; Mr. Daru has not yet been able to subdivide these.

## Burma.

55. **Mr. P. N. Datta: Kyaukse and Meiktila.**—Mr. P. N. Datta was engaged in the survey of the eastern parts of the Irrâwadi valley lying in the districts of Kyaukse and Meiktila and bounded on the east by the hills of the Shan States. The rocks met with consist of young clastic deposits, referred to the Pegu series on the west, and a group of older sedimentary rocks intimately associated with and altered by intrusive granite on the east. The older rocks consist of shale, sandstone and limestone, all frequently metamorphosed; in the absence of fossils, there is no evidence of their age, but Mr. Datta suggests that it may be Palæozoic. Felsite and andesite are also said to occur in this region, but their relationship to the other rocks is not stated.

56. **Mr. G. de P. Cotter: Yenangyaung and Minbu.**—While acting as "Oilfields Officer" at Yenangyaung during the early part of the year, Mr. Cotter visited the steatite mines in the Arakan Yoma and made some notes on the country traversed; no new facts, however, were brought to light. During the latter part of the year, he took up the systematic geological survey of the western part of the Minbu district including Hpa-aing and the eastern flanks of the Yoma; rocks of eocene and of so-called "lower eocene" age were found, the former yielding the usual "Khirthar" fossils. Serpentine intrusions are numerous. Owing to the unhealthiness of the season, Mr. Cotter was obliged through illness to interrupt his work, temporarily transferring operations to a less malarious area until the season should be more advanced.

57. **Mr. H. S. Bion: Upper Chindwin.**—During the latter part of the year, Mr. Bion took up a survey of the auriferous gravels of the Chindwin. His work has been noticed under *Gold* (para. 24).

58. **Sub-Assistant Sethu Rama Rau: Minbu and Pakokku.**—Sub-Assistant Sethu Rama Rau continued the mapping of the Tertiary beds on the west of the Irrawadi in the districts of Minbu and Pakokku. He completed the survey of the area covered by sheets 84 $\frac{K}{11}$ and 84 $\frac{K}{15}$ with the exception of the part already surveyed by Mr. Cotter. In the Minbu district he added the geology to parts of sheets 84 $\frac{L}{5}$, $\frac{L}{6}$, $\frac{L}{9}$ and sheet 110.

59. **Burmo-China Frontier.**—The results of the geological traverses made by Mr. Coggin Brown a few years ago in the neighbourhood of the Burmo-China frontier about Teng-yueh have now been embodied in a paper which will be published in a subsequent part of these *Records*.

60. The rocks met with are classified by Mr. Brown into six sub-divisions, *viz.* (in descending order)—

(6) Recent deposits;
(5) later Tertiary deposits of the Taping, Möng-hsa Möng-wan and Teng-yueh valleys;
(4) eruptive volcanic rocks of the Teng-yueh area;
(3) metamorphic rocks of the Kao-liang series;
(2) intrusive granites of the upper Taping valley;
(1) gneisses, schists and crystalline limestones of the frontier hills.

61. The crystalline series (1) covers the greater part of the country between Bhamo and the Salween; in the neighbourhood of Teng-yueh it is hidden as a rule by younger bedded deposits, but inliers of the old crystalline surface often appear. Granite (2) also occurs in considerable quantity.

62. The metamorphic series (3) consists of quartzites and phyllites, very similar to, and probably of the same age as, the Chaung Magyi series of the Northern Shan States.

63. The eruptive volcanic rocks, of which a separate description has been written by Mr. R. C. Burton (*supra*, para. 4) consist of andesites, basalts and pumice. They fall into an "older" and a "newer" group, the former consisting of grey, close-grained porphyritic andesites, which have a characteristic platy structure and are often folded. They are much older than the members of the "newer" group, although no age is assigned to them, but Mr. Brown seems to contemplate the possibility of their being as old as Palæozoic. The newer group consists of massive andesites, which are of Tertiary age and are again older than the black slaggy lavas of the still existing, though no longer active, vents.

64. The later Tertiary, as well as the Recent, deposits of interest are chiefly of lacustrine origin, the older being similar to those of the Northern Shan States and Tongking and probably of late Tertiary, and perhaps partly pleistocene, age.

65. Hot springs are very numerous in the district of Teng-yueh and are regarded as the last manifestations of the earlier intense volcanic activity.

## Central Provinces.

66. **Dr. L. L. Fermor and Mr. C. S. Fox: Chhindwara district.**—During the early part of the year, work was carried out by Messrs. Fermor and Fox in the valley of the Kanhan river and its bordering hills. Owing to the intricacies of the boundaries between the Deccan Trap and the Archæan granites and gneisses and the thickly wooded and sparsely inhabited character of the ground investigated, work was necessarily slow, but a total of some 300 square miles was mapped on the one-inch scale (sheet 53, C. P. Survey).

67. **The Archæan floor below the Deccan Trap.**—There is nothing to add to the account of the Deccan Trap formation given in the previous report, except to refer to the gradually decreasing elevation of the base of this formation as one passes from north to south. Thus, near Pardhan Ghogri the elevation of the base of the trap is 2,075 feet, whilst at Koprawari, only some 13 miles further south, it is about 1,400 feet. At the northern end of the valley the Archæan rocks are found to join the main strip of granites running westward from Chhindwara. It is evident from this and from the fact that granites and gneisses crop out on the Satpuras to the east of Seoni, that the Satpura range, which at first sight appears to owe its elevation to the presence of superposed flows of Deccan Trap lavas, is really a feature of the pre-Trap Archæan surface. Although there is a gradual decrease in the elevation of the

boundary between the Deccan Trap and the Archæan in passing from north to south, yet this change of elevation is locally very irregular and by means of aneroid readings it has been possible to detect many features of the pre-Deccan Trap topography. Thus the basal flow of Deogarh Hill and the underlying Lameta sediments, with those to the south-west of this hill, occupy an old river valley at least 50 feet deep.

68. **Nature of Lameta rocks in Chhindwara.**—Detailed examination of this boundary is necessary owing to the local variations in the thin band of rock usually intervening between the Deccan Trap and the underlying gneisses. This band must be correlated with the Lametas, since it agrees in many respects with occurrences seen in other parts of India; but as the result of detailed work it has been found that by far the larger proportion of this Infratrappean formation is not a sediment, but a rock of chemical origin formed either by the silicification or by the calcification of the underlying gneisses. Every gradation has been found from a fresh porphyritic gneiss, through a similar rock partially veined by chert and calcite, to a more completely replaced stage, in which the gneiss is seen in isolated patches in a network of secondary calcite, finally passing into a capping of typical siliceous limestone, to be distinguished in no way from the Lameta limestone of other parts of India.

69. **At Lameta Ghat.**—In November 1912, Dr. Fermor paid a brief visit to Lameta Ghat in the Jabalpur district, the original locality from which the rock took its name; here he found the limestone to be lithologically indistinguishable from the final products of the calcification of the gneisses in Chhindwara. The limestone of this locality rests, however, upon the sedimentary Jabalpur series of the Gondwana system; it will therefore be necessary to make a very careful study of the Lameta outcrops at Lameta Ghat and near Jabalpur in order to solve this problem satisfactorily. Meanwhile it is interesting to note that in thin sections under the microscope the limestone of Lameta Ghat itself shows evidence of secondary calcification. Provisionally, therefore, it may be regarded as probable that a considerable, if not large, proportion of the rock mapped as Lameta in different parts of India is of chemical origin. This would explain the extraordinary scarcity of fossils in the Lameta formation. A great variety of rocks have been found thus, replaced either by silica or by calcite. Amongst them may be enumerated several varieties of granite and gneiss, also hornblende-schist and crystalline limestone.

70. **Sedimentary Lametas.**—The detailed work along the Infratrappean boundaries has shown, however, that true sediments also occur. These are usually grits of various degrees of coarseness and are probably to be referred to the Lameta formation. At two localities Dr. Fermor succeeded in finding fossils. One of these was a specimen

of *Turritella?* in a piece of silicified rock near the hamlet of Kotmi, but a prolonged search did not lead to the discovery of any further specimens, whilst numerous specimens of *Paludina* were obtained from a siliceous grit at the second locality (about two miles north-west of milestone 23 on the Chhindwara-Nagpur road). The only exposure of the Lameta formation of any considerable size is that occupying the valley to the south of Deogarh Hill: it consists partly of grits and partly of clays.

71. The evidence concerning the date of formation of these calcareous and siliceous rocks is not yet regarded as conclusive by Messrs. Fermor and Fox, but in all probability the silicification was effected by solutions derived from the overlying Deccan Trap formation. It is possible that the Lameta limestones have been formed by the superficial replacement of the gneisses prior to the eruption of the Deccan Trap and the deposition of the sedimentary Lametas. If this deduction be correct the calcification and the silicification of the gneisses must be assigned to different periods, the silicification due to the Deccan Trap having affected both the fresh gneisses, the partially calcified gneisses, the so-called Lameta limestones, and the true Lameta grits, fossiliferous and unfossiliferous. In one place this silicification by the Deccan Trap was found to be accompanied by the introduction of heulandite into both the gneisses and the silicified limestones. But, on the other hand, it is much more probable that the calcification has been effected by solutions derived from the overlying Deccan Trap, in which case the calcification and silicification are to be regarded as two stages of one series of chemical processes.

72. **The Archæan rocks.**—The Archæan rocks in the area mapped are almost entirely granites and ortho-gneisses, metamorphosed sediments being practically absent, until the south-east corner of the sheet is approached, where, in the neighbourhood of Nautal, crystalline limestones are found in great variety. The Archæan gneisses are divided into two sections by a zone of intense crushing marked by rolled out and mylonitized gneisses stretching for 15 miles in a west-south-west direction from a point two miles south of Monkher to a point two miles south-south-west of Dhanora. This zone of crushing is accompanied by a strike fault, and the gneisses have been locally brecciated, and to a large extent replaced by white vein-quartz. In the eastern section this fault-breccia is from 50 to 100 feet wide and gives rise to steep bluffs and well-marked ridges; but in the western section it is either completely absent or only from a few inches up to 5 feet wide. The rock immediately north and south of the quartz-breccia is a hornstone-like rock, which, being really a mylonitized gneiss, has been termed hornstone-gneiss. This belt of crushing extends for about a mile to the north of the quartz reef, the degree of mylonitization of the gneiss decreasing with distance from the quartz-breccia. The mylonitized gneisses are succeeded to the north by intimately

associated porphyritic pink biotite-gneisses and melanocratic biotite-hornblende-gneisses rich in sphene. Still further north the foliation becomes less marked and the rocks may in places be termed porphyritic granites. On the south side of this quartz-breccia reef the rocks are mylonitized for a short distance and then give place to well-foliated schistose biotite-gneisses; and from the field evidence obtained it is deduced that the typical schistose biotite-gneisses of the Sausar Tahsil of this district may be merely foliated forms of the porphyritic granites of Chhindwara. The belt of crushing seems to be a fairly sharp dividing line between the porphyritic granite on the north, with its mylonitized and rolled-out derivatives, and the schistose gneisses on the south. Whereas the terms granite and gneissose granite would frequently be applied to the rocks on the north of the fault, the term gneiss is more generally applicable to those on the south.

73. **Their mutual relationship.**—Amongst the rocks south of the fault there are many varieties extremely rich in hornblende with every gradation between coarse-grained biotitic and coarse-grained hornblendic gneiss, whilst near Nautal a small area of true syenites has been found. Several occurrences have been found, also, of microcline-rocks, which must be regarded as an extreme variety of syenite. In many places throughout the Kanhan valley and that of the Nakta nala there are intrusions of pegmatites and of rather fine-grained granites, and although both these rocks seem to be on the whole distinctly younger than the porphyritic granites and their schistose and gneissose derivatives, yet the evidence obtained indicates a general relationship not only between the fine-grained granites and the pegmatites, but also between each of these rocks and the porphyritic granites and associated gneisses, and points to the probability that all these granites and orthogneisses are magmatic relatives and have been derived from one magma. This idea, however, of a common magmatic origin does not preclude the possibility that some of the gneisses may be of considerably greater age than the porphyritic granites and their derived gneisses.

74. **Pegmatites.**—The pegmatities are of considerable interest. Some of them contain only pink potash-felspar, whilst others contain both potash felspar and a white plagioclase, and still others contain only the plagioclase. Some of the pegmatite dykes are very coarse-grained in parts and have the constitution of fine-grained granites in other parts; one dyke in the Nakta nala consists centrally of a fine-grained granite, whilst both edges are very coarsely crystalline and have in places the constitution of a graphic granite.

75. **Epidiorites and basalt dykes.**—In the neighbourhood of Lawaghogri Mr. Fox found a series of lenticular outcrops of epidiorite intercalated along the foliation planes of the gneisses. They show every

gradation between a slightly altered dolerite and a hornblende-schist. In the same neighbourhood Mr. Fox has also traced several basalt dykes of Deccan Trap age traversing the Archæan rocks. In one case, near Narainghat, one of these dykes is directly connected with the overlying flow of basalt.

76. **Continuity of fault.**—The belt of mylonitization and fault-breccia already referred to is covered over at either end by the Deccan Trap lava flows and it is probable that it continues for some distance beneath the trap. If it continues to the north-east it should, if still existent, reappear somewhere in the neighbourhood of Seoni.

77. **Mr. Walker: Betul district.**—Mr. Walker was engaged in surveying the parts of the Betul district represented by standard sheets (1″=1 mile) 36, 37 and 53. The rocks met with belong to the same general groups as those of Chhindwara and include chiefly gneisses, Dharwar schists and Deccan trap, with Infratrappean and Intertrappean beds in places. To the south of a line drawn from Nilajhar (21° 55′; 78° 32′) to Amla (21° 55′; 78° 10′), the only rock found is Deccan trap, whilst to the north of this line gneisses and schists occur. On the whole, the gneisses play only a subordinate part; they consist of schistose biotite-gneiss with occasional patches and veins of aplite and intrusive masses of epidiorite and hornblende-schist. Dharwar schists are infolded with the gneiss along its margins. The Dharwar rocks comprise three general types, *viz.*, argillaceous sediments, as represented by phyllites, to the north of Kalmeshara (22° 2′; 78° 21′); micaceous quartz-schists and quartzites (metamorphosed arenaceous sediments) to the south of the same place; and old intrusive rocks now represented by epidiorites similar to those of the Kanhan valley, and found at Bordhai (22°; 78° 23′) and Harnia (21° 59′; 78° 22′).

78. Of the Infratrappean beds, Mr. Walker regards five small exposures, consisting of conglomerates, grits and clays, as perhaps of true sedimentary origin; between Nilajhar and Banga (21° 55′; 78° 25′) the trap is usually underlain by limestone and chert, which, as in Chhindwara, are regarded as due to secondary replacement of the underlying crystalline rocks through the contact action of the trap.

79. The Deccan trap is from 400—500 feet thick; the upper and lower flows are vesicular and crowded with geodes of quartz and chalcedony, but zeolites are rare. A slight dip to south-west has been noticed in the basalt flows. Basalt dykes have been found penetrating the crystalline rocks.

80. Intertrappean beds occur at three horizons; they are of the usual type and are often fossiliferous.

81. The schists and gneisses of the Bel valley show signs of considerable disturbance: faults are common, and, in the Dharwar schists, are

accompanied by brecciation; this has given rise to a series of ridges, which form conspicuous features in the local topography.

82. **Sub-Assistant Vinayak Rao: Seoni district.**—After accompanying Dr. Fermor for some six weeks and having become familiar with the sections in the Nakta nala, Sub-Assistant M. Vinayak Rao was sent to commence work on sheet 90 in the Seoni district, with special instructions to search for the continuation of the strike-fault and belt of crushing. He succeeded in finding crushed gneisses and in one place a breccia, approximately where expected. But the dynamic effects seem to be feebler in Seoni than in Chhindwara and split up into more than one belt. In conformity with this the general distinction between more granitic rocks on the northern side of the crush zone and more gneissose rocks on the south is less readily apparent than in the Kanhan area. In the time at his disposal Mr. Vinayak Rao nearly completed a preliminary survey of the whole of this sheet, the boundaries between the Deccan Trap and Archæan rocks being largely obscured by soil. To the south of Seoni a considerable area of laterite was discovered resting on the Deccan Trap, the thickness of the laterite being in one place as much as 140 feet.

83. In his progress report Mr. Vinayak Rao reports the discovery of two dykes near the village of Suktara, two miles north-west of Kanhiwara Railway Station. These have each a very irregular course and vary in width from a few inches to $2\frac{1}{2}$ feet; they are of tachylytic character, with chilled glassy borders.

## Kashmir.

84. **Messrs. C. S. Middlemiss and H. S. Bion: Kashmir.**—During the summer months Mr. Middlemiss, with the assistance of Mr. H. S. Bion, continued the revision of the geology of Kashmir. Work was taken up in the neighbourhood of Srinagar and continued round the north end of the valley, including also a portion of the Kishenganga drainage, during the first months of the season, and afterwards in the direction of the Marbal, Hoksar and Changam passes at the south-eastern extremity of the valley. Extensive new collections from the various old and some new horizons of the Silurian-Trias sequence have been made, and the mapping of the area in as much detail as possible carried on to a point where another season, it is hoped, will see the conclusion of the revised survey of the valley of Kashmir proper, that is to say, of all that portion lying within the Jhelum drainage area. It is also hoped that the new $1'' = 1$ mile maps recently made by the Survey of India will be used in this work, which will serve as a valuable basis for the larger and more difficult task of mapping the complicated metamorphic areas to the north, including Baltistan, the Karakoram and the Hindu Kush.

85. Among special results attained, the following may be mentioned: at Tregam (Trigamma) the limestone masses, as also those shown at intervals beyond to the north into the Kishenganga drainage and west again near Zunaresh, were found to be interbedded with the old slate system, and not to belong to the Zanskar system. This was verified by finding at several horizons in the slates interbedded with the limestones a Silurian *Orthis* fauna similar to that of Gugaldar, Gudramer and the Margan pass; the agglomeratic slate series, which comes between the Fenestella series and the Panjal Trap, and which hitherto had yielded no fossils, has now been found to contain at least two life zones, one coming a few feet below the base of the Panjal Trap and the other much lower down. Both are characterised by a rich *Syringothyris* fauna, together with a *Spirifer* allied to *S. Lydekkeri* Dien., *Fenestella, Productus* and *Camarophoria*. The lower horizon has so far been found only in the Marbal valley on the way towards the pass; it is very rich in material and of considerable thickness. The upper one is much thinner and is found in the Marbal valley and also at Nagmarg in Lolab.

86. A *Glossopteris* flora, with *Gangamopteris* and *Psygmophyllum*, has also been found just below the Panjal Trap in the Nagmarg sections.

87. In the Manasbal and Bandipur sections, Lydekker's conclusion that no Kuling series is there represented above the Panjal Trap was confirmed, and the most probable inference drawn that the volcanic activity of the Panjal Trap epoch extended up to the base of the Upper Trias in those parts, whilst again in the Imbersilwara hill mass, trap appears to be interbedded with the Upper Trias in a remarkably clear section.

88. A very rich Muschelkalk fauna has been found at many new places in the south-eastern part of the valley. In the Marbal valley the section from Karbodra down to Prumu in the Tansan river shows a wonderfully clear exposure, of about 20,000 feet thickness, through the Silurian-Trias sequence in fine normal folds of 15,000 feet double amplitude.

89. It is difficult to exaggerate the importance to Himalayan stratigraphy of the many discoveries made by Mr. Middlemiss in Kashmir during the last few years, for they have led to the solution of all those vexed questions which have hitherto barred the way to a satisfactory correlation of the various systems in the Jhelum basin with their less complicated representatives in Spiti and Kumaon. Of the work now under review the most striking feature is the complete manner in which Mr. Middlemiss has worked out the age of the Panjal Trap which he has shown to extend from Lower Gondwana to Upper Trias in some places, whilst disappearing in others at the end of the Permian period.

## Punjab.

90. **Dr. G. E. Pilgrim: Salt Range.**—From February until May 1912, Dr. G. E. Pilgrim was at work on the northern edge of the Salt Range, where he mapped in detail the ossiferous areas round Chinji and between Hasnot and the river Jhelum, collecting fully from the various stratigraphical zones. The following results of his observations are regarded by Dr. Pilgrim as of chief importance:—

(1) the occurrence at a low horizon in the Middle Siwaliks at Nagri of a fossil fauna believed by Dr. Pilgrim to be intermediate in character between that of Dhok Pathan and that of Chinji;

(2) the apparent absence of *Hipparion* from the lower 1,500 feet of the Chinji beds;

(3) the existence of unfossiliferous strata of Siwalik type, 1,700 feet thick, below the Chinji fossiliferous zone. This had previously been noticed by Mr. Vinayak Rao, who had, however, assigned the beds to the Gaj;

(4) in the Chambal ridge near the Jhelum river, a very distinct unconformity between the Upper and Middle Siwaliks. Many feet of Middle Siwalik strata are entirely missing including the fossiliferous horizon of Hasnot, the equivalent of that of Dhok Pathan. Going towards Hasnot the upper beds gradually come in, and the unconformity diminishes, though it is nowhere, perhaps, entirely absent;

(5) the fossils of the basal beds of the Upper Siwaliks at Tatrot, Kotal Kund, and some other localities have been erroneously united by previous collectors with those of the Middle Siwaliks of Hasnot, and Dr. Pilgrim now considers it necessary to remove from the Middle Siwalik fauna *Hippohyus*, *Sus giganteus*, certain bovines allied to *Bos* and *Anoa* and most of the *Hippopotamus* remains. These occur in the basal beds of the Upper Siwalik associated with *Hipparion*, *Stegodon*, and *Mastodon sivalensis*, it being noteworthy that no trace of either *Equus* or *Elephas* has been found.

91. Dr. Pilgrim considers that these facts, taken in conjunction with the recent discovery by Dr. G. Schlesinger of *Elephas planifrons* in a low zone of the middle pliocene near Vienna, afford additional evidence for the pontian age of the Middle Siwalik fauna of Dhok Pathan and Hasnot. He proposes the following classification for the Siwaliks of the

Salt Range, based partly on his past season's work and partly on the collections made from the Simla hills in 1911 by Mr. Vinayak Rao:—

| | | | | Feet above base. |
|---|---|---|---|---|
| Upper Siwalik | Boulder-bed zone. | | With *Camelus Equus, Elephas hysudricus.* | 15,000—17,000 |
| | Pinjor zone | . | Pebbly sandstones with *Hipparion* and *Elephas planifrons.* | 11,500—15,000 |
| | Tatrot zone | . | Conglomerates and grits with *Hipparion, Hippopotamus, Hippohyus* and *Mastodon sivalensis.* | 10,000—11,000 |
| Middle Siwalik | Bhandar beds | . | Unfossiliferous sandstones and clays. | 9,500—10,000 |
| | Dhok Pathan zone. | | Sandstones and clays with *Mastodon, Stegodon, Tetrabelodon, Hipparion,* large antelopes and giraffoids and *Tragocerus.* | 8,500—9,500 |
| | Nagri zone | . | Sandstones and clays with *Hipparion,* large antelopes, *Giraffokeryx* and a large giraffoid. | 5,500 |
| Lower Siwalik | Upper Chinji zone. | | Red nodular clays and sandstones with *Tetrabelodon, Hipparion, Hyæna, Hyotherium, Giraffokeryx, Protragocerus,* and a large antelope. | 3,200—4,000 |
| | Lower Chinji zone. | | Red nodular clays and sandstones with *Tetrabelodon, Hyotherium, Giraffokeryx, Protragocerus* and small antelopes. | 1,700—3,200 |
| | Lower Manchhar zone. | | Sandstones and concretionary beds, unfossiliferous in the Salt Range: in Sindw ith *Brachyodus* and *Hyoboops.* | Basal beds. |

# GEODESY.

BY

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## PRINCIPAL TRIANGULATION.

### Bengal and Madras.

*Orissa Division and Ganjam District. The Sambalpur Series.*

At the time of submission of last year's report to the Board of Scientific Advice, this series, which emanates from the Calcutta Longitudinal Series in latitude 23° 30′, longitude 85°, had been carried southward along the meridian of 84° as far as latitude 22°, to a point about 30 miles north of Sambalpur. During the season 1912-13, the series has been extended, still following the same meridian, through Sambalpur, the Orissa Feudatory States, the Khondmals and into the Ganjam District of the Madras Presidency, reaching a mean latitude of 19° 30′.

The heavily wooded, inhospitable, tractless country through which the triangulation had to be carried, put many difficulties in the path of the observer and gave promise of but slow progress. Nevertheless, two quadrilaterals, two tetragons and one hexagon were fully completed while a third quadrilateral was partially observed, extending the series by 167 miles. The area covered by these figures is 5,014 square miles.

The observations were made with Messrs. Troughton and Simm's 12 inch micrometer theodolite No. V. The average triangular error exhibited by the 22 triangles is small, 0·185″, the largest triangular error amounting to only 0·564″.

Two astronomical azimuths were observed, one at Sendur in latitude 20° 16′ and the second at Andhari in latitude 21° 58′.

After March 15th, no observing was possible on account of the haze and the smoke of forest fires, and operations had to be suspended.

Of this series, three more figures remain to be completed to effect a junction with the East Coast Series in the neighbourhood of Parlakimedi.

## SECONDARY TRIANGULATION.

### Central Provinces.

*Nimar and Betul Districts and Central India Agency. (Indore State.)*

To meet present topographical needs, secondary operations were commenced in the western portion of the Central Provinces and in the Central India Agency.

*The Khandwa Series*

This series, 141 miles in length, has been carried along the parallel of 22° between the Great Arc Series in longitude 78° and the Khanpisura Series in longitude 75°. It consists of 22 triangles covering an area of 1,820 square miles.

The observations were made with an 8 inch micrometer theodolite. The average triangular error was found to be 1·41″.

*The Akola Series.*

This is a meridional series emanating from the Khandwa series in longitude 76° 30′. During 1912-13, only the first four stations were selected and built. The series will be carried southwards during 1913-14 to effect a junction with the Bir Series in latitude 19°.

### Eastern Bengal and Assam.

*The Manipur Series.*

A commencement has been made on a secondary series which will connect the Assam Valley triangulation with the Manipur Meridional Series. It will eventually form part of the latter and the observations have, therefore, been carried out with a 12 inch theodolite similar to that used on the Manipur Meridional Series.

In March, low-lying haze covered the country through which the triangulation was being carried and rendered further observations impossible. Had it not been for the unfavourable atmospheric conditions, the series would have been completed. Seven triangles still remain to be observed.

*Khasi Hills. The Khasi-Garo Hills Series.*

In 1909-10, the Khasi and Jaintia Hills secondary series were run west and east from the Eastern Frontier Series in latitude 25° 30′. As,

however, this latter series was known to have been seriously disturbed by the earthquake of 1897, the positions of stations of the secondary series could be considered as only provisional until a connection could be made with a principal series further to the westward, out of the disturbed area. The opportunity to effect this connection was not forthcoming till this last season, when the Garo Hills secondary series was completed, joining up the Khasi and Jaintia Hills series with the Brahmaputra Meridional Series. The co-ordinates of points of all three secondary series will be recomputed, using the data afforded by the latter principal series.

## Bombay.

### *Bombay City and Island Triangulation.*

This triangulation, to serve as a framework for a large scale city survey, was commenced in 1911-12. It has now been completed and supplemented by precise traverse work. The framework comprises 112 permanent points distributed over the city and island. The positions of 65 of these have been determined by triangulation based on a side of the Bombay Longitudinal Series. Of the remaining points, the co-ordinates of 26, situated in the southern and central portions of the island, have been found by running traverses between the triangulated points. The positions of 21 points in the northern part of the island still remain to be determined by traverse.

On account of the difficulty of devising and erecting signals for observation in the densely crowded portions of the island, the determination of co-ordinates by the methods of triangulation could not be effected for all the points it was proposed to introduce into the framework. Recourse had, therefore, to be made to traverse operations. To obtain the requisite degree of precision, the steel 100 ft. tapes which were used (invar tapes not being available at the time) were compared daily with a standard of length laid down between brass plates set in the verandah floor of a suitable building; the temperatures of the tapes were determined from time to time during the day's work; the tapes were strained by the action of weights suspended over pulleys and auxiliary apparatus, reference marks, observation signals, etc., were specially designed.

In the computations, corrections for the temperature of the tape at the time of observation have been applied and all linear measurements have been reduced to terms of the standard length.

Final results are not yet available, but it may be of interest to note that the difference found between two linear measurements of the same traverse line made on different days amounted to 0·06 ft. in 5,131 ft., the ratio of difference to length measured being thus 1/85,500.

## Kashmir.

*Indo-Russian connection. Hunza Valley.*

In 1909, the International Geodetic Conference passed a resolution embodying the desirability of establishing a junction between the Indian and Russian systems of triangulation. Accordingly, during the summer months of 1911, reconnaissances were undertaken of the country intervening between the Kashmir Principal Series and the Pamirs with a view to discovering a practicable route to be followed in making the connection. Three schemes were suggested to the officers entrusted with the reconnaissances. The first was to extend the Kashmir Principal Series as far as the Sakiz Jarab range, on which stations would be established to the east of the Darkot pass. From these points, it was hoped, observations might be made to Concord and Salisbury peaks on the Afghan Russian border, which peaks would be included by the Russian observers in their triangulation on the Pamirs. The investigation of the practicability of this scheme was undertaken by the late Lieutenant Bell, R.E. He reported that the main chain of peaks of the Sakiz Jarab range was inaccessible and that the hills immediately to the south, only a little less difficult to negotiate, though they offered a satisfactory view to the north, were hidden from the south by high inaccessible masses effectually obstructing triangulation carried from the terminal points of the Kashmir series.

A second scheme involved the carrying of secondary triangulation from the principal series up the Yasin and Karamber valleys to the neighbourhood of the Gazan and Bhort passes, from which the Concord and Salisbury peaks might be visible. It was found that such triangulation could be carried as far as Harniot, but that, beyond this place, the valley narrows between precipitous hills to such an extent as to render further progress impossible.

The third alternative scheme was for secondary triangulation to break off from the principal series just south of Gilgit and to follow the Hunza and Kanjut valleys as far as the Kilik and Minktaka passes and from thence to extend over the Taghdumbash Pamir to a junction with the Russian points. This was found to be practicable. The valley as far as Hunza is comparatively open and the hills, though difficult, not inaccessible. Beyond Hunza, though the valley narrows somewhat, fairly well-conditioned figures can still be laid out as far as Misgar. Here in order to obtain triangles of sufficient length of side the series has to turn westward, out of the valley, and, bending again in a northerly direction, approach the Kilik pass from the south-west. From this pass the triangulation can be easily carried across the Taghdumbash Pamir to the Russian points near the Beyik pass.

It proved to be impossible to complete the whole of this connection in the season of 1912. The season was a short one and the detachment was continually hampered by unfavourable weather. Further, the death of Lieutenant Bell, R.E., who was in charge of the operations, caused a short cessation of the work and a dislocation of the arrangements made for its execution. The whole course to be followed by the triangulation was, nevertheless, reconnoitred in detail and, except for a distance of some 30 miles, the stations were selected and built. At a few of the stations at the northern and southern ends of the series observations were completed.

Operations were suspended between the end of October 1912 and May 1913, when the detachment returned to complete, it is hoped, the observations remaining to effect the desired connection.

*Note on the Base Line Apparatus of the Survey of India.*

As the Survey of India is now, after an interval of 32 years, about to turn its attention once again to base line operations, it may, perhaps, be of interest to review the past connections of the Department with work of this nature, more particularly in regard to the apparatus used, and to consider briefly the methods and equipment that will be employed in the measurements about to be undertaken.

When considering the past base line operations of the Survey of India, we find they fall into two groups, one covering measurements made between 1800 and 1825 and the second those between 1830 and 1870. From the end of the period covered by the second group till the present time, excepting one base measured in 1881, no operations of the kind have been undertaken.

We are now on the eve of a period which will give us a new group.

The triangulation has extended both to the east and to the west considerably beyond the network controlled by the base lines of the second group and additional lines for the verification of the new figures have been among the most prominent of geodetic desiderata during the past decade.

Between 1802 and 1825, during the first phase of development of the Survey of India, eleven base lines, the first operations of the kind carried out in India, were measured by Colonel Lambton. They were used to control the great network of triangulation which was then being extended over the southern portion of the peninsula, from Cape Comorin as far north as the parallel of 19°, for the purposes both of geodetic research and of topographical surveying. Below the latitude of 16°, eight of these base lines were distributed at intervals of from 90 to 250 miles over the whole area of the peninsula. The remaining three lines were

situated close to the meridian of 78°, between latitudes 16° and 24°, and were intended as checks to triangulation carried out mainly for geodetic objects.

The apparatus then available consisted of two 100 ft. steel chains, by Ramsden, and a 3 ft. brass scale made by Cary. One of the chains, received by the Survey in 1802, having been compared with the "standard in London" was never used in the field, but was maintained as a standard of reference with which the older chain was compared from time to time. This latter chain had a curious history, having been originally destined as a present to the Emperor of China and refused by him. It was afterwards taken to Calcutta where it was bought by Lord Clive, then Governor of Madras, and made over to Colonel Lambton.

The manner in which the measurements were performed was not always the same. At some of the base lines the chain was laid in a series of five wooden coffers, supported on posts and adjusted to the horizontal from end to end. The chain was strained by the weight of an $8\frac{1}{2}$ inch shell suspended from the forward end, the rear end being attached to a post by a device which permitted of adjustment of the rear defining mark over a reference mark on the ground. The transference of the defining marks to the ground was effected by means of a plummet. Five thermometers were placed alongside the chain in the coffers and the mean temperature indication was recorded. At other bases, the coffers were dispensed with, and the chain, laid on the ground carefully prepared beforehand, was strained by two small capstans. The tension thus produced could not be estimated nor regulated.

As linear units for geodetic survey, these chains were unsatisfactory. During the latter half of the period of their use, doubt gathered about the assumed invariability of the standard chain. There was no satisfactory means of checking its length and, in addition, there arose uncertainty as to the unit that had been employed in laying off its original length. Efforts were made to determine the amount of variation of the chain by periodical comparisons against a 100 ft. length laid off on a low wall by means of Cary's 3 ft. brass scale and a large beam compass, a procedure not calculated to lead to results of the precision requisite in operations of this nature. The results of these experiments threw suspicion on the accuracy of the comparisons and on the value assumed as the original length of the chain and led to a decision to reject the bases measured with it, as being insufficiently accurate for geodetic purposes and to obtain more efficient apparatus for the measurement of new lines on which to base the geodetic triangulation. This decision put a period to the first group of base line operations.

For the measurement of the lines which form the second group, the survey acquired, about the year 1830, two standard 10 ft. bars of wrought

iron and the Colby apparatus of compensated bars and microscopes. The bars were designated A and B and were of simple design. The section was a rectangle, 2 inches in depth by rather less than 1 inch in breadth, the ends of the bars being cut away to half their depth to allow of the defining dots, marked on platinum plugs, being placed in the neutral axis. Each bar was supported by rollers at one-quarter and three-quarters of its length.

Bar A became the Indian 10 ft. standard while Bar B appears to have been used as a means of comparing the Indian standard with those of other geodetic surveys. Bar A remained in India till the year 1908 and was used at the eleven base lines measured between 1832 and 1870, and in 1881. In February 1908 it was sent to Sevres to be compared with the international metre and returned to India in November of the same year. Bar B was sent to England in 1843 and was made over to the Ordnance Survey. Between that date and 1865, it was compared with the Ordnance standards and, by Captain A. R. Clarke at Southampton, with the 10 ft. supplementary bars $/_B$ and $/_S$ which were made for the Great Trigonometrical Survey in 1864.

From these comparisons, the relation between Bar A, defining 10 Indian feet, and the English standard yard was found to be—

Bar A = 3·33331886 times the yard at 62° F.

This value was determined by combining Captain Clarke's results with quantities observed by officers of the Great Trigonometrical Survey at Dehra Dun. Into its derivation, comparisons involving the Bars B and / were necessarily introduced.

Viewed in the light of modern comparisons, the precision of this quantity cannot be highly rated. The comparison was not a direct one; it was built up of observations some of which were made in 1865 at Southampton, others between 1867 and 1870 at Dehra Dun. Between the two periods, the bar $/_S$, which formed a link in the chain of comparison, made the voyage from England to India, and whether, during the period between the observations in England and those in India, the bar underwent any change of length there was no means of ascertaining. The bars were of materials possessing large coefficients of expansion and the precise determination of their temperatures during comparison was of the highest importance; the means then available, however, of ensuring steadiness of temperature and of providing that the thermometer reading should truly indicate the temperature of the metal bar must, to-day, be considered imperfect. In addition, judged by modern standards, the defining marks on Bar A cannot be held to admit of precise comparison. These marks are dots graved by a needle in platinum plugs and, when compared with the fine lines cut on a modern standard, they appear of excessive size, imperfect both in quality of outline and in shape.

However, this question of the relation of the Indian to foreign standards was, at the time, mainly academic. The uniformity of unit that now exists among associations and departments occupied in geodetic research had not yet established itself. There was no necessity for the reduction of our measurements to terms of any foreign unit. Bar A was accepted, not as an intermediary, but as the ultimate unit, whatever its length might be, of the Indian Survey. The junction of the Indian Survey with foreign operations was a factor so distant in the future as to be of negligible weight in considering methods and equipment.

The lengths of the base lines were first measured by the Colby apparatus and afterwards reduced to terms of Bar A by means of the relation of the Colby bars to this standard. The Colby apparatus consists of a set of six compensated bars and microscopes, the lengths of each of which was determined by comparison with the standard. A detailed description of the apparatus and the method of its use is given in the departmental records and it will be sufficient to remark here, that the term "compensated" was used in view of the fact that, in the construction of the bars and microscopes, advantage had been taken of the differences of the thermal expansions of brass and iron to devise an apparatus which would, theoretically, indicate a certain invariable length unaffected by changes of temperature.

The comparisons between the Colby bars and the standard A were made by bringing each bar in succession into the line joining the focal points of two microscopes erected, at a distance apart closely approximating to 10 ft. on masonry pillars. Micrometer measurements were then made with each microscope to the defining dots of the bar adjusted below it. A comparison of the measurements thus made gave the linear relation between the bars. The temperatures of the latter were assumed to be those indicated by thermometers, the bulbs of which were placed in small wells cut in the body of the bar and filled with mercury or oil to provide contact between the metal of the bar and the bulb. Some provision was made to procure steadiness of temperature during the comparisons by enclosing the bars in wooden cases, by protecting the comparison room from the sun's rays and by preventing the admission of the outer air.

Between 1832 and 1869, ten bases, all but one of lengths varying from 6·4 to 7·9 miles in length, were measured with this apparatus, one of them being the old chain measured base at Sironj. They served to control the geodetic triangulation which, in 1870, had extended over the whole of India Proper. Since 1870 only one base line has been measured. This was in 1881, at Mergui, to provide a linear datum for the operations about to be carried over Burma.

On these eleven bases, from 275 to 750 miles apart, depends the whole of the triangulation of the Survey of India, as it now stands.

During the last thirty years this triangulation has spread over Burma, on the east, and Baluchistan, on the west. In the north-east of Burma the triangulation has reached a point 700 miles from the nearest base in India and 1,000 miles from its own base in Burma. In the west of Baluchistan, there is triangulation 700 and 800 miles, measured along the chains of triangulation, from the nearest Indian bases. The necessity for providing some check for all this outlying triangulation, in the shape of additional base lines, has given rise to the third period of base line operations upon which we are about to enter.

The measurement of new base lines reopens the question of standards and measuring apparatus, questions, in some respects not so easy of solution to-day as they were eighty years ago. The science of geodesy has developed enormously, even in the last forty years, in matters connected with both methods and instruments. The range of materials and design of apparatus from which selection has to be made is greater now than formerly and, at the same time, greater care has to be exercised in making the selection as the criteria of good work have become more exacting. The creation of an International Geodetic Association has so stimulated interest and endeavour in the various branches of geodesy that, though sympathy and co-operation have been thereby fostered, questions which formerly roused merely local discussion, now attract widespread attention and possibly draw a greater variety of opinions to be weighed and considered. Moreover, in India, we are now effecting our first junction with a foreign system of triangulation and it is probable that in the not distant future we shall form other connections both to east and west, and matters, at one time only affecting ourselves and admitting of a purely local solution, must now be considered with a wider outlook.

When we came to enquire into the standards of accuracy now established abroad, the necessity for the adoption of such standards, and the possibility of attaining the necessary precision with our existing apparatus, it became quite evident that the old base measuring apparatus would have to be discarded. The lowest degree of precision now required in the case of a geodetic base may be represented by $\frac{1}{2,500,000}$ and a failure to attain this standard would almost certainly lead to the subsequent geodetic operations being considered as of almost negligible value. The Colby apparatus is unable to attain this degree of precision. The "compensation" principle involved in its construction, though sound in theory, was impossible of perfect materialisation. Though the thermal expansion of the Colby unit had been reduced to a very small quantity, the effects of changes of temperature had not been eradicated entirely. There was difficulty in ascertaining the temperature of the components of the unit and it had to be assumed that the temperature was the same for each component. The changes of temperature during field opera-

tions were often considerable and the validity of this assumption was very doubtful.

Moreover, by reason of the complexity of the apparatus, the many adjustments that had to be made and the cumbrous nature of the pieces, the field practice was laborious and slow. Though, in its day, it was probable the best base measuring apparatus that had been devised, it must now give way to modern apparatus more portable and simple, yet, at the same time, permitting of the attainment of a higher degree of precision.

The apparatus generally in vogue to-day is designed, in one form or another, to apply Jäderin's system of measurement by wires hung in catenary. This type of apparatus, simple of construction, has been found to combine high accuracy with great portability, rapid progress and simplicity of field procedure. It is an apparatus of this nature that has been chosen to supplant the Colby bars.

But, entangled with the question of measuring apparatus was that of standard and unit. The accuracy of a measurement with any base line apparatus depends ultimately on the precision with which a certain length can be laid off with the basic standard. It had to be considered whether the precision attainable in an operation of this kind made with the present 10.ft. Bar A was of a degree that allowed full advantage to be reaped from the accuracy of measurement attained by the wires themselves; whether the quality of Bar A, as a standard, was sufficiently good to justify its being used in combination with the new apparatus. The enquiry into these matters made it evident that the precision attainable by the intermediary instrument, that is to say, the apparatus with which the actual measurements will be performed, is of a higher order than that inherent in the ultimate unit, the standard, and the retention of the latter could not be justified. It was necessary to declare as obsolete, not only the Colby bars, but also the standard Bar A of 1832. Both measuring apparatus and standard having to be replaced by modern types, the question arose whether this new equipment should be in terms of the foot or the metre. For the sake of simplicity in the operation of comparing base line apparatus with standard, all the equipment should be in terms of one and the same unit. For the purposes of geodesy, it was immaterial which unit was adopted, but, in consideration of the fact that the metre has been adopted now by practically all other geodetic bodies and for the sake of uniformity and the simplification of discussions dealing with work common to our own and to other systems of triangulation, in which the metre would most probably be the unit, it seemed desirable to abandon the foot and to adopt the metre.

The outcome of the decision to use the metre as the unit of future operations will be that the base line measurements of the third group

will be in terms of an abstract unit, whereas those of the second group were in terms of a concrete unit, Bar A.

The change of unit having been decided upon, new metre standards and base line apparatus were designed and constructed for the Survey of India. The equipment of standards consists of two 4-metre bars, one of invar, the other of nickel-steel (42 per cent. nickel) and two one-metre bars, one of invar and the other of pure nickel. They are all of the same type of section, a flanged H with the defining graduations cut on the upper surface of the cross bar. The 4-metre bars are graduated at every metre of their length, permitting of the determination of their linear value in terms of the one-metre bars.

If it be found that the use of a 4-metre bar is necessary in the field, the invar bar will in all probability be employed as the field standard while the Ni-steel will be maintained in Dehra Dun as a reference bar.

The most important desiderata in regard to a standard bar are a small thermal expansion and a great molecular stability. So far no metal or alloy has been found to combine in itself these two characteristics and it is to allow us to profit by the advantages conferred by both that two 1-metre bars have been provided. The invar bar, having a small thermal expansion, is little susceptible to changes due to temperature variations, while the nickel, though having a much larger coefficient of expansion, is more stable than the invar and less subject to molecular changes.

The length of each 1-metre bar has been determined in terms of the international metre.

Modern ideas of accuracy and the high degree of refinement attained in the construction of standards of length and observing instruments demand the taking of extreme precautions in the carrying out of bar comparisons. The chief difficulties to be contended with arise from changes and irregular distribution of temperature and, consequently, we find in modern comparators elaborate devices for ensuring steadiness and controllability in this respect. The old type of comparator existing at Dehra Dun, in which bars under comparison were but indifferently protected from temperature disturbances, will be replaced by apparatus permitting of the control of temperature to $0^{\circ}\cdot01$ C. and by which almost perfect uniformity of temperature distribution is secured.

The description of this new comparator is briefly as follows:—

On two masonry pillars, about 2 ft. high and 15 ft. apart, rests an iron box-girder, suitably protected from the effects of changes of temperature. Held in mountings capable of movement along the face of this girder, are two microscopes fitted with micrometer eye-pieces. The mountings can be clamped at any point on the girder, permitting of

the microscopes being placed at any distance apart from 0·5 metre to 4 metres. Below the girder, on rails laid transversely to its length, travels a platform carrying two tanks, each about 14 ft. long. These tanks are fitted to receive the bars under comparison. One tank will accommodate two bars, side by side, while the second will take only one, the bars being so placed as to be entirely immersed when the tanks are filled with water. In connection with the tanks are motor-driven pumps, capable of circulating the whole of the water in the tanks in 90 secs. In the circuit between the pump and the larger tank are an electric heater and a thermostat. By the operation of the former, the temperature of the water can be raised by rather more than 3° C. per hour. The thermostat is designed to automatically control the action of the heater so that, when the water has been brought to any required temperature, it can be steadily maintained within 0°·01 C. of this point. The temperature is indicated by several thermometers placed alongside the bars.

The small tank, having no heater, is designed to maintain the bar within it at a steady normal temperature. The larger tank provides the means of raising one or two bars to, and keeping them at, any temperature, for the time being abnormal.

By suitably selecting the positions of the microscopes on the girder and traversing the platform along the rails till a bar arrives in the correct position below the microscopes, micrometer observations can be made on the terminal graduations of the bar. If two bars are brought in succession under the microscopes, comparative readings can be made which will allow of the length of the one being deduced in terms of that of the other.

The provision of two tanks, in one of which the temperature may be regulated as desired, makes it possible to carry out a series of comparisons between two bars, one of which is maintained at a constant normal temperature for the whole duration of the observations, while the other is brought to a different temperature for each comparison of the series. Utilising the length of the bar under constant temperature as a datum for the time being, the length of the second bar at varied temperatures can be determined and the characteristics concerning its dilatation investigated.

By placing both bars under comparison in the same tank, determinations can be made of their relative lengths at any and the same temperature.

The comparator thus affords means of investigating the coefficients of expansion of the bars and of determining their lengths in terms of an adopted standard.

The base measuring apparatus consists of a set of 24-metre invar wires designed for use by Jäderin's system.

The determination of the length of a base necessitates the adjusting of the wire in successive positions which, starting from one end of the base, finally close on its further terminal. In each position of the wire the points defined by its limiting graduations are indicated by adjustible reference marks. The mark indicating the forward graduation of the wire in one position becomes the point to which the back graduation must be made to correspond in the next successive position. The determination of the true distances between these reference marks in each position constitutes the fundamental operation in the measurement of a base.

In each position, the wire is hung "in catenary," supported on two pulleys and strained by the action of weights.

The final length of the base is derived by combining the individual measurements given by each of the set of, generally, three wires.

To arrive at the length of the base, it is necessary to know the relation of the distance between the terminal graduations of the wire when hung in catenary, to the ultimate standard. To obtain this relation between our 24-metre wires and the international metre, a 24-metre comparator will be erected in Dehra Dun. The comparator consists of seven microscopes, securely mounted at intervals of 4 metres along a low masonry wall. Below the microscopes are laid rails along which travels a cradle designed to carry one of the 4-metre bars. By moving the cradle along the rails and thus bringing the 4-metre bar opposite each of the 4-metre intervals between microscopes, in succession, and by taking micrometer readings with each microscope of the bar graduation below it in the successive positions of the bar, it is possible to determine the distance separating the extreme microscopes in relation to the length of the 4-metre bar, which, by means of the 4-metre comparator, can be ascertained in terms of the international metre, as represented by the 1-metre standards.

Having determined the length between the extreme microscopes in metres, to get the length of each wire, all that remains to be done is to suspend each wire, in turn, below these microscopes and observe the positions of their defining graduations.

It will not be necessary to move this 24-metre comparator and a 4-metre bar into the field to the site of the base line to be measured. The procedure to be followed will be to standardise six wires at Dehra Dun, before departure for the field; on arrival at the base line, to lay out a 24-metre length between suitable marks on masonry pillars by means of three of the wires, which will, henceforth, not be used in the actual measurement of the base but be maintained as reference wires for the periodical checking of the distance between the marks on the pillars, the field comparator. The remaining three wires will be used to measure the base, their lengths being compared daily with the field comparator. On re-

turn from the field all six wires will again be standardised by means of the 24-metre comparator and thus a check obtained on any variations of length which may have occurred in the field.

## PENDULUM OPERATIONS.

During the season 1912-13 measurements of gravity were made at 14 stations along a line extending from Bhopal to Khurja, near Bulandshahr, including Kalianpur, the station of origin of the Indian triangulation. The results are shown in the summary.

The three last columns in the summary need to be explained. The first, headed $(g_o - \gamma_o)$ shows the amounts by which gravity is in excess or defect on the assumption that surface masses have no effect thereon, the height of the station being alone allowed for in deriving $g_o$, the value of gravity at sea-level, from $g$ the observed value. This method of reduction is sometimes known as the free air method.

The second $(g_o'' - \gamma_o)$ shows the excesses or defects on the assumption that all visible masses are of mean surface density and are entirely uncompensated. $g_o''$ is derived from $g_o$ by the application of Bouguer's rule. Unless otherwise stated it is these residuals that are referred to in the subsequent discussion of results.

The third column $g - \gamma$ gives the residuals based on Hayford's hypothesis of isostasy or underground compensation of surface masses.

We have now completed a chain of stations along the meridian of 78° from Mussoorie (latitude 30° 28′) to Amraoti (latitude 20° 56′), a distance of about 650 miles, and it may be interesting briefly to review the results.

From Mussoorie to Gesupur (latitude 28° 33′) the defects of gravity decrease rapidly from ·11 to ·02 dynes. Between Gesupur and Khurja we find a rise to ·04 and from thence to Agra the negative residuals again decrease, becoming positive at the latter station. Between Agra and Bina we find 2 belts of deficient gravity or "valleys" separated by a positive area or "ridge." From Bina to Amraoti we have a succession of positive values with only two small negatives at Bhopal (·004) and Shahpur, latitude 22° 12′ (·005).

The existence of this area of excessive gravity, often called the hidden chain, was deduced by Colonel Burrard in 1901 from the evidence of the deflections of the plumb line. The pendulum has verified it, and this year the northern edge has been located between Kalianpur and Goona. This fact lends strong probability to the assumption that the deflection of the plumb line at Kalianpur is southerly.

It is interesting also to note that the positive areas at Sipri and Agra and the sudden change between Khurja and Gesupur are indicated

by the plumb line deflections in these localities. This seems to show that the variations of density which produce these abnormalities are situated near the surface.

Mention was made in last year's report of the investigation of the isostatic correction to gravity results. This has now been extended and about 40 stations have been dealt with. Generally speaking the effect of this new method of allowing for the effects of the topography is to decrease negative residuals and increase positive ones at all stations except those near the sea coast. At coast stations positive residuals are decreased. At stations which are distant both from the sea and from mountains the change amounts to from 0·03 to 0·05, but near the sea and near mountains much greater changes are produced. The following table shows a few of these changes:—

| Station. | Locality. | $g_o''-\gamma_o$ | $g-\gamma$ | Change. |
|---|---|---|---|---|
| | | Bouguer. | Hayford. | |
| Mussoorie . . | On the edge of the Himalaya . | −·110 | +·075 | +·185 |
| Dehra Dun . . | 7 miles from Himalaya . . | −·126 | +·029 | +·155 |
| Nojli . . . | 65 „ „ „ . . | −·095 | −·007 | +·088 |
| Gesupur . . . | 130 „ „ „ . . | −·020 | +·029 | +·049 |
| Chatra . . . | 180 „ „ „ and coast | +·009 | + 030 | +·021 |
| Madras . . . | On coast . . . . . | +·014 | −·025 | −·039 |

As will be seen from the summary of results and the table above the great majority of the Hayford residuals are positive. This merely means that another formula for computing $\gamma_o$, the normal value of gravity at sea-level, will have to be used. The point to be noted is that the Bouguer residuals are as a rule negative near hills and positive near the coast and that the new method will reduce the residuals in each case. Local anomalies, such as have been found during the last season, will, however, not be affected.

## *Summary of results, 1912-13.*

| Station. | Latitude. | Longitude. | Height above M. S. L. | Observed value of $g$. | Correction for | | | $g_o = g$ corrected for height only. | $g_o'' = g$ corrected for height and mass (Bouguer). | $\gamma_o$ | $g_o - \gamma_o$ (Free air). | $g_o'' - \gamma_o$ (Bouguer). | $g - \gamma$ (Hayford). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Height. | Mass (Bouguer). | Mass (Hayford). | | | | | | |
| | ° ′ ″ | ° ′ ″ | Feet. | Dynes. | Dynes. | Dynes. | Dynes. | Dynes. | Dynes. | Dynes. | Dynes. | Dynes. | Dynes. |
| Bhopal . . . . . | 23 15 58 | 77 25 00 | 1,630 | 978·711 | +0·152 | −0·057 | −·007 | 978·863 | 978·806 | 978·810 | +0·053 | −0·004 | +·046 |
| Balianpur . . . . . | 24 07 11 | 77 39 17 | 1,763 | 978·717 | +0·164 | −0·062 | −·011 | 978·941 | 978·879 | 978·867 | +0·074 | +0·012 | +·063 |
| Kina . . . . . | 24 10 41 | 78 11 46 | 1,355 | 978·795 | +0·126 | −0·047 | ±·000 | 978·921 | 978·874 | 978·871 | +0·050 | +0·003 | +·050 |
| Goona . . . . . | 24 38 48 | 77 19 13 | 1,569 | 978·807 | +0·146 | −0·055 | −·007 | 978·953 | 978·898 | 978·903 | +0·050 | −0·005 | +·043 |
| Lalitpur . . . . . | 24 41 29 | 78 21 26 | 1,199 | 978·814 | +0·112 | −0·042 | +·003 | 978·926 | 978·884 | 978·906 | +0·020 | −0·022 | +·023 |
| Sipri . . . . . | 25 25 52 | 77 39 25 | 1,533 | 978·876 | +0·143 | −0·054 | −·009 | 979·019 | 978·965 | 978·958 | +0·061 | +0·007 | +·052 |
| Jhansi . . . . . | 25 27 02 | 78 33 43 | 858 | 978·910 | +0·080 | −0·030 | +·007 | 978·990 | 978·960 | 978·959 | +0·031 | +0·001 | +·038 |
| Gwalior . . . . . | 26 13 57 | 78 12 49 | 658 | 978·958 | +0·061 | −0·023 | +·012 | 979·019 | 978·996 | 979·015 | +0·004 | −0·019 | +·016 |
| Dholpur . . . . . | 26 42 01 | 77 54 47 | 577 | 978·999 | +0·054 | −0·020 | +·015 | 979 053 | 979 033 | 979·048 | +0·005 | −0·015 | +·020 |
| Agra . . . . . | 27 10 20 | 78 01 07 | 535 | 979 056 | +0·050 | −0 019 | +·018 | 979·106 | 979·087 | 979·083 | +0·023 | +0·004 | +·041 |
| Mattra . . . . . | 27 28 25 | 77 41 48 | 562 | 979 072 | +0 052 | −0 020 | + 019 | 979·124 | 979·104 | 979·105 | +0·019 | −0·001 | +·038 |
| Hathras . . . . . | 27 36 52 | 78 03 22 | 587 | 979·075 | +0·055 | −0·021 | +·020 | 979·130 | 979·109 | 979·116 | +0·014 | −0·007 | +·034 |
| Aligarh . . . . . | 27 53 32 | 78 00 31 | 612 | 979·075 | +0·057 | −0·021 | +·021 | 979·132 | 979·111 | 979·137 | −0·005 | −0·026 | +·016 |
| Khurja . . . . . | 28 14 19 | 77 51 53 | 649 | 979·083 | +0·061 | −0·023 | +·024 | 979·143 | 979·120 | 979·163 | −0·020 | −0·043 | +·004 |

$$\gamma_o = 978{\cdot}00\ (1 + 0{\cdot}00531\ \mathrm{Sin}^2\ \phi)$$

## LEVELLING OPERATIONS.

During the year 1912-13, the following lines of precise levels were run:—

### (*a*) *In Kashmir.*

Kohala to Srinagar.
Srinagar to Islamabad.
Islamabad to Phalgam.
Srinagar up the Sindh Valley.
Srinagar towards Bandipur.
Srinagar towards Shopian.

### (*b*) *In the Punjab.*

Multan to Mahiwala.
Ambala to Jagadhri.
Delhi to Hodal.
Murree to Kohala.

### (*c*) *In the United Provinces.*

Jagadhri to Meerut.
Meerut to Delhi.
Hodal to Muttra.

### (*d*) *In Bengal.*

Comilla to Chittagong.

Brahmanbaria *viâ* Ashuganj, Bhairab, Dacca and Goalundo to Faridpur; crossing the Meghna, Lakhya, Dhaleshri and Padma rivers, distances across being, respectively, 65, 35, 52 and 109 chains of 66 feet.

To cross the first three rivers, the "target" method was adopted, and for the last, vertical angles were observed.

The line Dacca to Mymensingh had been included in the programme, but it was not found possible to complete it. It will be completed in 1913-14.

### (*e*) *In Burma.*

Henzada to Bassein along the left bank of the Ngawun river.
Pegu to Mokpalin.

In the programme it had been intended to carry this line on to Magwe which would have completed the first circuit in Burma, but owing to stress of weather, work was stopped at Taungdwingyi, some 60 miles distant from Magwe. It will be finished in 1913-14.

The line Thazi to Taunggyi had also been included in the programme, but it was not found possible to take it up. It is now intended to complete it in 1913-14.

In addition to the above lines of precise levelling, about 41 miles of single levelling were carried out at Darjeeling, in the cantonments of Takdah and Lebong and in the Happy Valley landslip-area, as an aid for the surveying of contours for large scale maps of these places.

## TIDAL OPERATIONS.

During the year tidal registrations by automatic tide-gauges have been continued at the following ports, with satisfactory results:—

Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein, and Port Blair.

# BOTANY.

## I.—BOTANICAL SURVEY.

BY

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**Eastern India.**—The work of the Royal Botanic Garden, Sibpur, has become so closely associated with the work of the Botanical Survey that an account of the progress made by officers in their former capacity must find a certain degree of repetition in the Botanical Survey Report. During the year under review, the Director in his capacity as Superintendent of the garden has continued the work of cataloguing initiated by him in 1909 and progress has also been made with the preparation of the systematic list which is intended to be supplementary to the numerical and in which the plants will be arranged according to their Natural system of classification. The numerical list itself is far from complete. In the list as it stands there still remain many blanks to fill up and the addition of new material to the garden will involve additional numbering while the extraction of what dies or has for other reasons to be removed naturally renders such a list useful only within a limited period. The systematic list which it is intended to prepare should serve the useful purpose of letting one know at a glance what the garden actually possesses and the garden numbers which will also be inserted will allow of reference to the plants themselves, without the extra trouble of looking over pages of the numerical list before the particular plant wanted is recognised. The work when completed should form a most useful aid in systematic work, for if doubt is entertained regarding the identity of any species sent in for examination a ready reference will be had to the living plant itself as well as to the dried herbarium material. In July 1912, Volume V, No. 4 of the Records of the Survey appeared and the list as stated in last year's report now totals some 13,400 numbers. As regards the indentification of critical species and the subsequent filling in of blanks a large number of plants of doubtful standing which had accumulated and awaited a favourable opportunity for study was taken by Major Gage to Kew where it is hoped sufficient material will be available to allow of comparison and systematic classification. Signor Beccari continues to investigate the garden palms which are at present most in need of study and several species formerly of

doubtful standing have been identified. Lately a large consignment of these has been forwarded for favour of report, but it is not always possible with palms to send at one time the complete material which a critical study requires as many of the more interesting flower and fruit at irregular intervals. Already a list of useful identifications has been forwarded by Signor Beccari and his requests for complete material are being complied with as the more critical species come to maturity. Outside Eastern and Southern India the limited staff of the Botanical Survey has been able to accomplish no field work, but various collectors who have been engaged in other directions have sent their material for report and record. In January and February of 1913 Major Gage toured in parts of Burma and was thus able personally to supplement the excellent work done by Forest and other Government officers and private individuals on whom the Survey has had to depend so much for material from this province. The collections come mostly from the higher elevations 2,000—4,000 feet. They number some hundreds and were got to the Herbarium in excellent condition. These have been sent to Kew but were first roughly classified before despatch. Time has not yet permitted of their being worked up, but doubtless interesting records will accrue from their examination. The parts explored lie in North Arracan and the Toungoo district of Burma. In North Arracan Major Gage studied the vegetation of the district East of Paletwa which lies between the Kaladan and Mee Rivers and spent a good deal of his time on Kyaukpaudaung Peak. In Lower Burma he botanised in the locality of Thandaung, North-East of Toungoo. In both districts the idea followed was that of intensive collection from a limited area rather than extensive work covering a wider field. During the year Volume IV, No. 7 of the Records of the Botanical Survey has appeared. This number is devoted to a record of the exploration undertaken by Mr. W. W. Smith, late Curator of the Herbarium, in 1910 and treats of the Alpine and Sub-Alpine vegetation of South-East Sikkim. In all some 925 plants are recorded, an interesting general account of the flora is included and the following new species are described in the list:—*Paroxygraphis sikkimensis*, *Draba cholaensis*, *Arenaria Balfouriana*, *Potentilla microphylla* Don., var. *pusilla*, *Saxifraga Gageana*, *Saxifraga pluviarum*, *Trachydium affine*, *Leycesteria Belliana*, *Senecio biligulatus*, *Senecio Kingianus*, *Senecio Lagotis*, *Senecio Chola*, *Saussurea nimborum*, *Saussurea Laneana*, *Gentiana pluviarum*, *Swertia ramosa*, *Swertia Burkilliana*, *Pedicularis siphonantha* Don., var. *prostrata* Bonati, *Pedicularis sikkimensis* Bonati. Two species of *Juncus* may prove to be undescribed species but they require fuller investigation and comparison with ampler material of the genus. In Burma collections were made by Mr. J. H. Lace, late Chief Conservator of Forests, and Captain Abbey and over 200 sheets have been forwarded from this source to the Herbarium for report as well as a small collection from Mr. C. G. Rogers. Among those sent by Mr. Lace, were

several which would have formed useful additions to our Burma material and some of these Mr. Lace has kindly allowed the Herbarium to retain. Mr. Lace has also found it possible during the year to complete his materials for a "List of trees, shrubs and principal climbers recorded from Burma" and the work has now been published. The arrangement follows that of the Flora of British India except that there is an alphabetical arrangement of the species under each genus and Burmese, Kachin, Karen and Shan names are supplied. The work should prove an excellent reference list to students of the flora who can already claim a certain acquaintance with systematic work. The flora of Burma has also received the marked attention of Mr. C. G. Rogers, Conservator of Forests, who continues to submit from time to time small collections for comparison with the Sibpur material. During the year a collection of between forty and fifty sheets has been received from this source and the more useful we have been allowed to retain for the Burma local Herbarium. Botanical exploration in Bhutan has not always been an easy matter in the past, not on account of the area itself offering insuperable difficulties to such work but on account of difficulties in obtaining permission to enter the territories. The acquisition of some 200 specimens collected in this comparatively unworked region by Mr. Jacob, who has been deputed there as Forest officer, is therefore all the more worthy of note. Such a collection even in conjunction with what has already been done on the flora gives but a very superficial knowledge of its wealth, but such forms as *Eleagnus pyriformis* Hook. f. *Argyreia Hookeri* C. B. C., *Schima Wallichii* Choisy, *Anisochilus polystachyus* Bth., *Strobilanthes pentstemonoides*, T. Anders. *Stephania elegans* Hf. & T., *Priotropis cytisoides* W. & A., *Ajuga macrosperma* Thw., *Lysionotus serratus* Don., *Strobilanthes coloratus*, T. And., var. *crinita*, *Daphniphyllum himalayense* Muell. *Photinia integrifolia* Lindl. *Heracleum nubigenum*, C. B. C. *Clematis nepalensis* DC., *Holmskioldia sanguinea* Retz., *Dipsacus inermis* Hf. & T., *Bridelia sikkimensis* Gehrm., *Senecio Bhot* C. B. C., *Natsiatum herpeticum* Ham., and *Wendlandia pendula* DC., at once mark the district as typically East Himalayan in its flora. The last named species is recorded for the first time from Bhutan. Other collections from Northern India include some 500 sheets from Mr. Cave, Curator of the Lloyd Botanic Garden, Darjeeling, and a collection similar in numbers from Mr. B. J. Gould, British Trade Agent in Gyantse. The last named collection though somewhat incomplete as regards the individual specimens nevertheless afforded a number of useful additions. This is only to be expected when one considers the limited amount of biological exploration that has been possible in Tibet. Among those identified there are present *Scutellaria Kingiana* Prain, *Triglochin martimum*, L., *Anemone trullifolia* Hk. f. & T., var. *linearis* P. Bruhl. *Meconopsis paniculata*, Prain., *Braya tibetica* Hk. f. & T., besides many others of interest which have filled

gaps in the general and local Herbaria. A very valuable set of Wight's plants numbering upwards of 7,000 sheets have been presented by the Regius Keeper of the Botanic Gardens, Edinburgh. These have been drawn from all parts of the Peninsula and the co-types which are included add greatly to the value of the set as a whole.

It is not always possible to make analytical work in the Herbarium keep pace with field work but several collections made prior to the year under review have undergone examination. In 1911-12 Mr. Meebold toured in Mergui, Thaton and Salween in Lower Burma and his plants which have now been worked out are useful as showing the occurrence of well marked endemic forms of typical Malayan species and the relative scarcity of Upper Burma species. This is exemplified by the following few species which find a place in the list *Ixora opaca* R. Br., *Glochidion insulare* Hook. f., *Ervatamia cylindrocarpa* King and Gamble, *Embelia nagushia* Don. A new species *Cleistanthus Meeboldii* Jabl. has also been recorded as well as *Cleistanthus myrianthus* and *Cleistanthus Helferi* Hk. f. A small collection of plants made by the same Botanist at Mungpoo in the beginning of 1912 has also been worked up and several gaps in the local Sikkim Herbarium filled though the list shows no new records. During the year Captain Toppin's Kampti Long Mission collections made in 1911-12 have been named with the exception of the genera Quercus and Begonia. A large number of species that were formely supposed to be endemic only in Upper Assam is represented in this collection while a few Chinese plants are also to be found. The families Leguminosæ, Rubiaceæ and Acanthaceæ are well represented. Considering the area dealt with in the collection it would seem that there is quite an appreciable endemic element and a number of new species seems assured. The whole collection has gone to Kew for revision and a report will probably be given on it at a later date. In 1911 Mr. I. H. Burkill and Mr. S. C. Banerji undertook a tour in the Khasia and Jaintia Hills which resulted in the acquisition of nearly 800 sheets. These have now been studied and have resulted in the following new records for the district *Spiræa micrantha* Hk. f., *Rosa Leschenaultiana* W. and A., *Webera corymbosa* Willd. *Leptodermis lanceolata* Wall. *Taxotrophis zeylanica* Thw. Among those examined was also a Sagittaria sagittifolia L. with the leaves elliptic instead of, as is usually the case, hastate, a form which is said to be of rare occurrence.

Mr. Gamble has continued his work on the flora of the Malayan Peninsula and during the year an account of the families *Myristicaceæ*, *Monimiaceæ*, *Thymelaeaceæ*, *Elaeagnanceæ* and *Santalaceæ*, has appeared in the *Journal of the Asiatic Society of Bengal.* Five new species are described of which *Santalaceæ* has four and *Thymelaeaceæ* one.

Mr. W. G. Craib has published his second list of Siamese plants with descriptions of new species. The list comprises the monocotyledons and

the following new species are dealt with. *Globba Kerrii* Craib, *Globba Nisbetiana* Craib, *Globba purpurascens* Craib, *Globba xantholeuca* Craib, *Globba Yeatsiana* Craib, *Curcuma ecomata* Craib, *Amomum siamense* Craib, *Zingiber Bradleyanum* Craib, *Zingiber Kerrii* Craib, *Zingiber Smilesianum* Craib, *Halopegia brachystachys* Craib, *Tacca Garrettii* Craib, *Stemona aphylla* Craib, *Stemona Kerrii* Craib, *Smilax Hemsleyana* Craib, *Disporopsis longifolia* Craib, *Ophoipogon brevipes* Craib, *Ophiopogon gracilipes* Craib, *Chlorophytum intermedium* Craib, *Chlorophytum simplex* Craib, *Aneilema discretum* Craib, *Aneilema siamense* Craib, *Pandanus distans* Craib, *Pandanus similis* Craib, *Arisaema hypoglaucum* Craib, *Arisaema Kerrii* Craib, *Arisaema sootepense Craib*, *Amorphophallus macrorhizus* Craib, *Mariscus Clarkei* Turrill. A new cycad *Cycus immersa* Craib, is also described. The same author has also described *Flemingia Lacei* Craib, *Flemingia augusta* Craib, *Agapetes Lacei* Craib, *Agapetes oblonga* Craib, *Wightia Aplinii* Craib, all new species from Burma. *Primula Wattii* King ex Watt, a species originally met with in Sikkim has also been described by Mr. Craib in the Botanical Magazine No. 1507, where a figure of the plant is also to be found. Mr. Gamble has described the new species *Loranthus Robertsonii* Gamble, *Henslowia Collettii* Gamble, *Henslowia shanensis* Gamble from Burma, *Erytranthe papillosa* Gamble, *Erytranthe Barnesii* Gamble, *Erytranthe Robinsonii* Gamble, *Erytranthe Wrayii* Gamble, *Viscum Wrayii* King ex Gamble, *Viscum flexuosum* King ex Gamble from the Malay Peninsula and *Viscum costatum* Gamble from the Darjeeling district.

Sir David Prain has described three new species of *Helicia* from the Malay Peninsula *Helicia Kingiana*, Prain, *Helicia rufescens* Prain and *Helicia velutina* Prain. Mr. N. E. Brown has contributed a description of *Gentiana minuta* N.E. Brown from the Tunkra Pass in the Himalaya and Mr. S. T. Dunn of *Crotalaria Meeboldii* Dunn and *Polygonum palmatum* Dunn, both from Assam. Other noteworthy species described include a *Cornus* by Dr. Stapf and a new species *Berberis Parkiana* Schneider from the Western Himalaya.

The flora of Indo-China continues to receive the attention of M. Gagnepain and several fasciculi of his Flore Generale de l'Indo-Chine have been published during the year. The treatment of the subject is exhaustive, the last fasciculus to hand comprising 100 pages devoted exclusively to the *Leguminosæ*. Roxburgh's Hortus Bengalensis published nearly a century ago and his catalogue of described plants which had at that time not yet been introduced into the garden have been reviewed by C. B. Robinson, an American botanist, who supplies some interesting observations on the nomenclature used.

**Western India.**—Mr. D. Hooper has contributed 600 sheets to the Herbarium, some of these having come from the Western side of the

peninsula. Apart from this contribution little has been done by the Botanical Survey staff in the way of field work on the west. A review of the publications of the year, however, will show that botanical work is being well supported there. The Orchids of the Bombay presidency are receiving the attention of Mr. G. A. Gammie who is adding from time to time in the *Journal of the Bombay Natural History Society* to our knowledge of the family while Father Blatter's exhaustive account of the Palms of British India and Ceylon also being continued is a work of which Indian Botanists may well be proud. The same author has now completed his flora of Aden which will appear in parts of the *Records of the Botanical Survey of India* at an early date. The flora gives a history of the Botanical exploration of Aden, a description of the physical aspects, a full general account of the vegetation wild and cultivated, a complete synopsis of the natural orders and descriptions of all the species amounting to 250 nearly thrice as many as described by Anderson 50 years ago. Keys are supplied and also an exhaustive bibliography.

Mr. R. K. Bhide has described two more species of *Gramineæ* from Bombay.

**Northern India.**—Colonel C. J. Bamber has added in the *Journal of the Bombay Natural History Society* several additions to his plants of the Punjab, North-West Frontier Province and Kashmir, while Herr Schneider has described a new *Berberis* from the Western Himalaya and cites the area as possessing many new and curiously localised species of the genus. Regarding this interesting addition—*Berberis Parkeriana* collected by R. N. Parker in Hazara—he remarks as follows:—

"Ich erhielt diese Art von Herrn R. N. Parker aus Lahore, welcher sie im Hazaradistrikt (westl. Himalaya) sammelte, und zwar die Blutenzweige in Bagnolar Reserve, 2600 m, April 1910, und die Fruchttriebe in Abbottabad, 1800 m, Juli 1910. Sie gehort in die Sektion Tinctoriæ C. S. (Eutinctoriæ), wo sie aber von allen bisher bekannten Arten durch die lanzettlichen, unterseits nicht papillosen Blatter abweicht. In der Blattform ahnelt sie sehr B. lycium, diese hat aber unterseits weisspapillose Blatter und langere Trauben. Herr Parker bemerkt zu seinen Pflanzen; B. calliobotrys? Die Fruchte erinnern auch an die B. calliobotrys Aitch., allein diese Art hat kleinere Blatter, kahle, braunrote junge Triebe und weicht auch in den kleineren Blutenstanden und sonst ab."

**Southern India.**—Apart from the publication of botanical work concerned with this part of the peninsula a considerable advance has been made with the collection of materials for the survey. Southern India and Burma will require in the future the increased attention of the Botanical Survey staff for large areas, the knowledge of the flora of which is comparatively scanty, remain for exploration. During the year the Director was able to depute two of the staff Mr. Hooper and Mr. Ramaswami to Tinnevelly and a survey of two taluks Ambasamudram

and Nanguneri in the district was undertaken. Copious notes were made and the expedition resulted in the acquisition of about 700 sheets. Time has not permitted of the whole collection being worked out, but so far as it has been studied it would seem that the family *Leguminoseæ* with fifty-two species is the most widely represented. *Rubiaceæ* comes next with thirty-seven species; *Compositæ* has thirty-two, *Convolvulaceæ*, *Acanthaceæ*, *Labiatæ* and *Filices* twenty-four each, *Verbenaceæ* has eighteen and *Euphorbiaceæ* and *Urticaceæ* thirteen each. The remaining families contain fewer than ten species each. The flora of the plains as might be expected shows a striking similarity to that of the adjacent island of Ceylon, while the hills possess a flora comparable with that found on the slopes of the Nilgiris. Even in the hills, however, there are local variations of the flora due chiefly to local variations in rainfall. As the survey of the district proceeds full reports will appear of its vegetation, but the following few endemic species may now be mentioned as forming part of the collection:—*Leptonychia moacurroides* Bedd., *Homalium travancoricum* Bedd., *Hedyotis purpurascens* Bedd., *Vernonia travancorica* Hook. f., *Blepharispermum petiolare* DC., *Symplocos acuminata* Bedd., *Diotacanthus grandis* Benth., *Mallotus stenanthus* Muell. and *Elettaria cardamomum* Maton. the last named found wild only in this part of India.

Mr. C. E. C. Fischer, Deputy Conservator of Forests, continues to be one of the mainstays of botanical work in this part of the peninsula and has this year contributed over 600 sheets from Coimbatore, Anaimalai and Palni Hills. Numerous interesting records accrue, including some examples of new species recently described by Mr. W. W. Smith from Southern India. During the year the survey has been fortunate in enlisting the services of the Reverend St. Münch, S.J., and the Reverend A. Sauliere, S.J., both of the S. H. College, Shembaganur, and both of whom have ungrudgingly contributed large collections from the Madura district and done much to help on the survey in the Peninsula. Over 700 sheets have been forwarded for identification from this quarter, but the limited staff of the Herbarium has not been able to cope with all demands for floral analyses, and a considerable number of the Madura plants still await examination. From what has been accomplished, however, it becomes evident that the typical Deccan element is well represented in the district explored. A short extract from the report of the Government Botanist, Madras, on Systematic Botany is of interest in connection with South Indian Botany. "All the specimens collected by Dr. Barber, except imperfect and unidentifiable sheets have been identified and incorporated with the main collection. Besides these 887 sheets of specimens of plants collected by Dr. Bourne on the Pulney hills and 691 sheets of Mr. Gamble's collection were also incorporated. The Grewias sent to Kew for identification were returned. In this lot eight

species are new to science; *i.e., Grewia Wightiana, G. Griffithiana, G. Gamblei, G. Lawsoniana, G. Wattiana, G. Barberi, G. Optiva, G. pandaica.* A further lot of Grewias was again sent for identification. About 50 sheets of duplicate specimens of Grewias were sent to Mrs. Bourne. During the year 1,633 sheets were named and names were written on 2,404 sheets. All the original pencil drawings of Wight and Beddome's published works received from Ootacamund have been sorted and mounted in albums. About 150 plants were identified for various correspondents."

**General Systematic.**—M. G. Dismier has done much to clear up the confusion which existed in regard to Indian and other Asiatic species of *Philonotis* and has set forth his views based on examination of material from the more important European collections, on the characters which separate *Philonotis falcata* (Hook.) Brid. and *Philonotis Turneriana* (Schw.) Mitt. from nearly allied species. He has been able to include in the synonymy list numerous species which rightly have only varietal rank and to furnish critical remarks concerning the species he considers synonymous. A treatment of their geographical distribution adds to the value of the discussion. In *Philonotis falcata* (Hook) Brid. he has been able to include some twelve and in *Philonotis Turneria* (Schw.) Mitt. some four species. As regards his views on the distinguishing characteristics of these the following may be quoted from the Bulletin de la Société Botanique de France. "Toutefois, il me parait nécessaire, au préalable, d'indiquer de quelle manière je comprends les *Philonotis falcata* et *Philonotis Turneriana.* En général, chez ces deux espèces, les feuilles sont ovales-lancéolées, acuminées et disposées en rangées spiralées. Quelques spécimens cependant ne paraissent pas, á première vue, offrir cette disposition caractéristique; mais, en les examinant avec soin, on finit toujours par trouver quelques tiges ou portions de tiges à feuilles sériées. J'insiste sur cette disposition spéciale car elle a pour moi une valeur de premier ordre; elle ne m'a jamais fait défaut dans tous les échantillons—et ils sont nombreux—que j'ai étudiés. J'ajouterai que ces feuilles, chez le *Philonotis falcata* de même que chez le *Philonotis Turneriana*, sont carénées, concaves, â bords plats, et â dents simples sur tout le contour; vues au microscope sous le couvre-objet, elles sont, par suite de leur concavité, les unes condupliquées, les autres fendues sur une assez grande longueur. Quant aux cellules elles sont carrées ou brièvément rectangulaires et papilleuses à leur partie supéricure; de plus, chez le *Philonotis falcata* la nervure est de largeur moyenne, tantôt percurrente, tantôt plus ou moins excurrente, tandis que chez le *Philonotis Turneriana*, qui n'est, à mon avis, qu'une sous-espece, elle est toujours longuement piliforme."

Since last report was written several volumes of Das Pflanzenreich have appeared and the following families are discussed—*Geraniaceæ*,

*Goodeniaceæ, Brunoniaceæ, Araceæ, Cannaceæ, Euphorbiaceæ.* The value of this work which is the result of years of study by some of the best Botanists in Europe can scarcely be overestimated. It comprises the most noteworthy species known all the world over and reference to the work will show the richness of India in species in comparison with other countries. Several revisions of genera of interest to Indian botanists have appeared during the year. M. R. Benvist has dealt with the structure and classification of the *Acanthaceæ* of the tribe *Barleria*, the genus *Cousinia* has been dealt with by Bornmüller, the *Gentianaceæ* of Indo-China by Dop. A revision of *Saxifraga* section *Hirculus* and new species of other sections has formed the subject of investigation by Engler and Irmscher who have described amongst others the following new Indian species:—*Saxifraga Kinchinjungæ, S. sikkimensis, S. Kingiana* (S. Gageana) *S. eglandulosa, S. chumbiensis, S. subspathulata, S. elliptica* varieties of *S. diversifolia, S. pseudo-hirculus, S. punctulata, S. flagellarioides, S. Andersonii* all from Eastern Himalaya and Calcutta garden collections also *S. Meeboldii* from N. W. Himalaya.

Mr. Gagnepain has published a further fasciculus of his Flora Generale de l'Indo-Chine incorporating his work on the *Leguminosæ* of that region.

Mr. S. T. Dunn who has had much Indian material at his disposal has revised the genus *Millettia* and the following new Indian species and varities are recorded:—*Millettia Griffithii* Dunn, *M. eriocalyx* Dunn, *M. Pulchra* Kurz., var *microphylla, M. trifoliata* Dunn, *M. podocarpa* Dunn, *M. Prainii* Dunn, *M. Cubitti* Dunn. The bibliographical list will show the chief botanical works of a general kind having reference to Indian botany, which have come under notice.

**Anatomical and Physiological.**—The structure of the female Strobilus of *Gnetum Gnemon* has been dealt with by Mr. E. M. Berridge. The first stages of the development of *Terminalia Catappa L.* has found the subject of a study by M. Colani. Herr Hanausek has studied the pericarp and pericarp secretion in the genus *Carthamus*, Mr. Hector, Economic Botanist to the Government of Bengal, has experimented on the pollination and cross fertilisation of the common rice plant *Oryza sativa* Linn. Mr. E. L. Stephens has been engaged on the anatomy, structure and development of *Striga lutea* Lour. and numerous other Botanists have added materially to our anatomical and physiological knowledge by studies conducted with Indian material or adduced results which can be made applicable to Indian Botany. The Royal Botanic Garden has been instrumental in collecting and forwarding material of *Gnetum* at various stages of development to Professor Pearson who is engaged in a study of the development of the ovule and the results of whose observation are awaited with interest. Further references on anatomical and physiological subjects may be seen in the bibliographical list appended.

*A list of papers containing references to the Botany of India published mostly during 1912-13.*


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## II.—ECONOMIC BOTANY.

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### Part I.—AGRICULTURAL BOTANY.

BY

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Considering the number of workers in the field, the output of research in Agricultural Botany is, as usual, small. There are, however, very few, especially in the Provinces, who have any time to deal adequately with this important subject. With hardly an exception, the Provincial Agricultural Botanists report that almost the whole of their time is taken up in teaching. Preparing courses of lectures in a country where the very alphabet, in the shape of species, is new, is no light matter, and it must take some time before the new officers have much to say on the applied science, but there are signs that a change is taking place and that more time will be available for research than heretofore. In Madras the much-needed change has taken place during the year and teaching and research have been definitely separated under whole-time officers. In the other Provinces the teaching courses are rapidly becoming stereotyped and more attention is being paid to the collection and study of groups of the cultivated plants. A considerable amount of time is being devoted to the economic survey of the crops grown in India, wheat, sugarcane, cotton, paddy, tobacco, pulses, oil seeds, capsicums, peppers and mangoes having received special attention during the year. Added to this general survey, pure line cultures have been instituted in most of those mentioned.

One of the most striking characters in Indian crops, grown for centuries under the same conditions, is the enormous extent of admixture of varieties in almost every field, and perhaps no part of the world offers a finer field for investigation to the Economic Botanist In many cases, mere separation of the various types by pure line culture has led to great agricultural progress, while the field opening up for the creation of new varieties along Mendelian lines is a vast one and full of promise, it having been abundantly demonstrated in every crop investigated that there is a large margin within which improvements may be effected. This is perhaps the most promising line of work before the Agricultural Department at the present moment, and it is sincerely to be hoped that

the example of Madras noted above may be followed elsewhere and that the excellent work now being done by the purely agricultural members of the service may be stimulated and encouraged by placing full-time officers in charge of breeding work, the teaching in the Colleges being provided for by the creation of a special teaching staff. Attention is strongly drawn to the fact which has been emphasised by the work of the Howards on wheat, that breeding work is more difficult than was at first anticipated, and that improvement of crops, by the creation of new varieties combining the useful properties of several parents, can no longer be approached lightly. Meanwhile, the mere selection of varieties is leading to important results and it is becoming increasingly certain that, unless full time is available for breeding work and great care exercised in its prosecution, the results are likely to be disappropriating.

An attempt will be made in the present report to deal as widely as possible with the crops being studied and thus to indicate the directions in which future expansion may be looked for. The important work on wheat and cotton, which has filled most of the previous reports, will be more briefly summarised.

**Paddy.**—There are various indications that this, the most important food crop in the tropics, is at length about to receive the attention it deserves.

Hector has made a survey of the chief Aman transplanted paddies of Lower Bengal. In the 150 varieties which he has isolated and grown in pure lines, he has found that the morphological and cultural characters are transmitted, and no case of crossing has occurred in his pure line plots. The correlation between the varietal and field characters and the composition of the grain is being studied by him in conjunction with the Agricultural Chemist. He has, further, made a study of paddy pollination, and disagrees with Knuth as to the normal dehiscence of the anthers. He finds that paddy in Bengal behaves in the manner described by Akemine in Japan and van der Stok in Java. According to these observers, self-fertilisation is the rule, while crossing occasionally takes place, so that it is necessary to be on the guard against this in breeding work. According to Hector, arrangements are made at the moment of the opening of the flower for immediate anthesis, so that the stigma, still enclosed in the flower, is copiously dusted with pollen from the same flower. In his comparison of the anthesis and flower-opening of the Aman and Aus paddies, he finds differences which he considers to be due to varying degrees of moisture and temperature at these two periods of the year. A little pollen being left in the anthers after the opening of the flower, cross-pollination is possible. Hector has not apparently observed this, but he infers it from the observed characters in the offspring which, when selfed, reproduced the parental peculiarities in Mendelian proportions. He concludes, however, that cross-pollination in

paddy is strictly limited, and only takes place between plants growing in close proximity.

Hilson has made a series of observations on the pollination of paddy in Madras and has commenced a study of the varietal characters which appear to be inherited. Graham in the Central Provinces has completed the survey of the paddies grown, the material accumulated being preserved in 1,345 herbarium sheets. He has isolated 81 varieties and grown them in pure line cultures, and certain of the better kinds have been handed over to the farms for propagation and distribution. Sawyer and Thompstone have done similar work in Burma, pure line cultures having been grown for a couple of years, and a great demand has arisen at the Mandalay farm for certain better kinds.

The purely agricultural work continues. Paddy transplantation in the Central Provinces now extends to 16,000 acres, with an average increase in yield of one-third of the crop, and great hopes are entertained of a further expansion of this work. In the same way the campaign in single-seedling planting has been vigorously continued in Madras and the method is being tested in various other Provinces. It is notable that both in the Central Provinces and in Madras it is claimed that these simple improvements in the method of planting will, in time, amply cover the total cost of their respective Agricultural Departments in increased production. The distribution of improved or pure seed continues to increase, between 30,000 and 40,000 lbs. having been sold during the year in Madras alone.

**Wheat.**—The excellent work done by the Howards on this important crop continues to yield valuable results, and several papers have been published during the year, while their efforts at improving the Indian wheats have been ably seconded in the various Provinces interested in this crop, especially by Leake in the United Provinces and Clouston in the Central Provinces. It is not proposed to deal with these papers at length in the present report, partly because some attention was drawn to them last year while in the press, but chiefly because of the absence of the authors in England and the extreme importance and intricacy of the subject.

Considerable progress has been made in the study of the inheritance of morphological characters. It has been demonstrated, in confirmation and extension of the work of Nillson-Ehle at Slavöf, that apparently simple characters, such as the red colour of the grain, the hairs in the chaff in felted wheats, bearding, shattering of the ear, and so forth, are really complex and dependent on several factors. It has, further, been demonstrated that the influence of the environment cannot be ignored in these studies, as it is found sometimes to clock inherited characters of minor importance, thus rendering the isolation of new kinds more complicated still. It is not to be supposed that wheat is peculiar in this respect

among Indian crops, and this makes it all the more necessary that workers in this branch of agricultural improvement should be able to devote their undivided attention to it and be freed from all other claims upon their time. As the authors point out "plant breeding has been started at stations as an addition to an already over-loaded programme and the result has been to flood the literature with a mass of superficial results of no permanent value. Whenever plant breeding has been done with thoroughness, and on a sufficiently large scale, it has invariably been found that the inheritance of characters is by no means such a simple matter as at first supposed, and the investigations conducted at such centres as Slavöf explain why it is that the numerous attempts at plant improvement made at Agricultural Experiment Stations have not led to any striking results."

Extended trials have shown that high yield and good quality can be combined in the same plant, while it has been proved that the excellent properties of the Pusa wheats can be preserved under different environmental conditions. This latter thesis is developed in an important paper under the joint authorship of the Howards and Leake of Cawnpore. A series of Pusa wheats were grown under the varying conditions of ten stations in the chief wheat tracts of India, and the results carefully analysed. While it transpired that the conditions of climate and soil exercised a marked influence upon the character of the produce, it was also shown that the good characters of the Pusa wheats were largely maintained, and this in rain-fed land and under irrigation, in the lighter soils of the Gangetic plain as well as in the heavy black cotton soils of the Central Provinces, provided that careful attention was paid to good agricultural practice.

It is an interesting and important fact that the conditions tending to produce good quality in wheat are identical with those producing high yields. Further experiments with hot-weather cultivation tend to show that this treatment is cumulative in its effects, the best results having been obtained in the second and third years. The importance of drainage is emphasised by an ingenious experiment whereby it was demonstrated that the poor yield in badly drained lands is due to nitrogen hunger. Continuous growth of wheat on the same land without manure gave a still higher yield in this, the fifth, year of the experiment and it is considered that the limits of the capacity of the soil have probably been reached.

The principal wheat work in the near future, besides the purely Mendelian study of the inheritance of characters, will presumably be the maintenance in a pure state of the improved types raised. Ample arrangements are meantime being made for the multiplication of the best kinds. There is an increasing demand in Bihar and it is hoped that from 10,000 to 15,000 acres will be under these varieties during the

present year. It is proposed to put down 100 acres on Leake's new farm at Aligarh, while arrangements are being made in different tracts in the Central Provinces for raising a large amount of seed.

**Cotton.**—There is little work of a purely botanical nature to record regarding this crop. A paper in the press by Leake on the vegetative characters of cotton appears to consist largely of summaries of previous work, amplified by the results of various crossings. It deals with pollination, the colour of the corolla, the red matter in the sap, the leaf factor, the type of branching and the length of the internode. The systems of classification of cottons published by Todaro and Watts are criticised in the light of these new factors and it is specially pointed out that these systems have taken no account of the modes of branching in the various types. Using this character, Leake proposes a tentative classification which may be further considered when the paper is published.

Leake and Parr have contributed an important paper on the problem of improving the existing cottons in the United Provinces, in which they emphasise the importance of dealing only with readily tangible superiority in the introduction of new strains. From various considerations they come to the conclusion that, unless this superiority amounts to at least 25 per cent. of the value of the existing crop, it is idle to attempt to establish a new form. A careful study is made of the whole question in the light of experience gained during the work of recent years, and stress is laid on the improvement of the ginning quality as the most readily appreciable improved character. The authors lay great stress upon the importance, in any improved variety, of having some distinguishing mark by which, it can at once be recognised in the field.

The rest of the cotton work of the year consists of the continued segregation of various pure types from mixed crops and the founding of distributive agencies for such as have been proved to be more profitable than the local growth, whether in better lint, better ginning percentage, greater outturn and greater resistance to disease. It is obviously of little avail, in a crop where crossing in the field is a proved and constant factor, to be satisfied with small, isolated experiments, and every effort is made to deal with as large areas as possible and to ensure that the whole tract dealt with takes up the cotton distributed. From this point of view, the work of the year may be considered to be eminently satisfactory and large distributions have taken place in Tinnevelly, the northern districts of Madras, the Central Provinces, Bombay and the United Provinces, while interesting facts regarding the quality and outturn have been brought to light in the Punjab, the North-West Frontier Province and other parts of India. The most important types at present being dealt with appear to be Karungani in Tinnevelly, Tellapathi in the Northern Circars of Madras, Rosea in the Central Provinces and Bhuri

where wilt exists, Navasari (Broach) in the Deccan, improved Broach in Guzerat, Rosea in Khandesh, and white flowered (Varhadi) in Aligarh. Cambodia is making rapid progress in Madras where there is an increase in the total cotton area (an increase of 600,000 acres this year), undoubtedly largely due to recent introductions of better class cottons. Cambodia has also been proved to be eminently suited to the Dharwar American tract in Bombay and its cultivation there is rapidly extending.

**Sugarcane.**—In last year's report it was mentioned that the appointment of a full-time sugarcane expert was contemplated, whose main work would be the study of the sugarcanes of India and if possible the production of seedlings of improved quality. This appointment has been made during the year and a cane breeding station has been opened at Coimbatore. The preliminary work carried out by Barber while Government Botanist in Madras was referred to is last year's report and it was stated that the problem of raising canes from seed had been successfully solved. A considerable amount of progress has been made during the year under report.

It has been found that some of the North Indian canes, grown at Coimbatore, flower freely, but that the inflorescences, instead of being perfectly sterile as they appear to be in North India, are provided with large quantities of open anthers with fertile pollen. Provisional experiments have resulted in about 100 seedlings being raised from these canes. A much larger number of seedlings were obtained from the arrows of canes growing round Coimbatore and, although the arrowing season was exceptionally unfavourable because of heavy rains in the middle of November succeeded by a long spell of dry weather, some 12,000 to 15,000 seedlings were obtained in place of the 50 grown in the previous year. Of these, 2,000 have been selected for growing on and examination and most of them are thriving well at the time of writing. About 30 of last year's seedlings were closely studied from every point of view. Their morphological characters received special attention and these were compared with those of their parents with the idea of obtaining some information as to value of the characters from a systematic point of view, nothing being at present known on this subject. They were also very carefully studied in their earlier stages in order, if possible, to obtain criteria for the early rejection of unsuitable forms. The chemical analysis showed that the seedlings of the same parents varied a good deal in sugar content, but that those of different origin approximated somewhat to their parents in this character. A certain relation also appeared to exist between vegetative vigour and sugar content, and it is unfortunate that these seem to vary inversely, the most vigorous seedlings (one of which produced 143 strong canes in twelve months from sowing) having usually very poor juice. On the whole, the results are encouraging and one at least of the first year's seedlings

would appear to be worth trying under North Indian conditions, as it has a very fair proportion of sugar, pure juice and a considerable amount of vigour. It was unfortunately necessary to grow these seedlings on land entirely unsuited for sugarcane cultivation, and, for this reason, it has been thought wise to grow the whole again on the cane farm to check the results and, incidentally, to test the fixity of the characters observed.

The collection of varieties has been largely increased by the addition of canes collected during two long tours in North India and considerable progress has been made in the study of their morphological characters with the prospect of an ultimate classification of the Indian canes. In order to obtain some idea as to the canes most usefully employed as parents, a large number of analyses made in the past have been accumulated, special assistance having been given in this matter by the Imperial Agricultural Chemist and the Agricultural Chemist of Madras. The collection of varieties was greatly helped by the officers in charge of the Sabour, Pertabgarh, Aligarh and Gurdaspur farms.

Some interesting scientific results have accrued from the study of such wild Saccharums as have been obtained. Successful crosses have been made between *Saccharum spontaneum* and two North Indian forms, Chin and Shakarchynia, and this fact, coupled by strong resemblance in the vegetative characters, makes it appear probable that at any rate a number of the North Indian canes have arisen from this wild species, or are very closely allied to it. This conclusion has obtained a certain amount of support from the curious belief expressed by the cultivators round Gurdaspur that their canes, among the most primitive in India, have arisen from a wild grass which appears, from a cursory examination, to be a variety of *Saccharum spontaneum*. But this study of wild species was undertaken with the purpose of learning the systematic value of the vegetative characters, and a good deal of information has been obtained on this point. A number of seedlings were raised from *Saccharum spontaneum* which flowers freely round Coimbatore, and out of these two very different types have been selected for further study. Upon analysing their juice it was found that the more vigorous type contained nearly 3 per cent. of sugar while the stunted slow-growing form had nearly 5 per cent., a curious commentary on the relation between vegetative vigour and sugar content mentioned above in sugarcane seedlings. The other wild Saccharums studied, Narenga, Munja and arundinaceum, appear to differ widely from cultivated sugarcanes.

At Sabour, Woodhouse and Taylor continued their study of the canes of the tract, grown now in pure lines for four years. They have brought together the results of this study and these are awaiting publication.

At Aligarh the distribution of *Saretha Desi* continues to increase, some 200 acres being planted up of this variety in the neighbourhood of

the farm. As a certain amount of prejudice was expressed against this cane because of its habit of free flowering, Parr conducted experiments as to the relative *gur* production and suitability for seed purposes of flowered and unflowered canes. In each case the flowered canes were in no way behind the unflowered. The popularity of the Mauritius canes introduced at this farm continues and it is hoped that there will be a great extension of these kinds as they have proved superior to the local chewing canes.

At Jorhat in Assam, Meggitt has shown that several of the West Indian seedlings are capable of yielding large quantities of sugar per acre of good quality, and are therefore suitable for employment if sugar factories are contemplated.

In Madras the acreage under Red Mauritius continues to increase. A record specimen of Striped Mauritius has been figured, 29 feet long and with 23 feet of cane. On the West Coast B 208 appears to give better results than Red Mauritius and it is gradually supplanting that kind in some places, the sugar industry having received a great impetus from the work on the Taliparamba farm. Over 125,000 sets were distributed during the year.

Several new farms have either been opened during the year or are proposed in the main North Indian sugarcane tracts. One of the objects of these farms will be to test the canes produced at the Coimbatore farm.

**Tobacco.**—The Howards continue their study of this crop, the inheritance of leaf characters being the work of chief scientific interest during the year. The attempt to produce a good cigarette tobacco has met with considerable success and a consignment of leaf prepared from a selected type, specially cultivated and cured by a modification of the local method in Bihar, was valued at Monghyr at considerably above the normal price.

The Director of Agriculture in Burma considers that the haphazard distribution of Havana and Virginian seed in past years has had an appreciable effect on the quality of the local leaf. He proposes to continue and systematise these importations.

**Soy Beans.**—Woodhouse and Taylor have published an important Memoir giving the results of their work on Soy Beans for several years. It contains an account of the varieties found in the plains and hill tracts of Bengal and Bihar and Orissa and deals with the unit characters by which they are differentiated. It is interesting to note that many of the varieties from the hill tracts are similar to the Chinese types imported into America, while none of these types are found in the plains, on which the varieties are of long, straggling habit. The most interesting characters dealt with are the percentages of oil and nitrogen in the seeds, which appear to be inherited separately. The differences in the

oil content of pure lines of the different varieties were found to be inherited.

Agriculturally, some of the varieties have given satisfactory yields in the hills and plains, but in the plains the ordinary varieties have the disadvantage of occupying the land for two seasons. A sufficiently high price is not yet offered to encourage its growth for export.

Further work is being done with this crop at Sabour. It has been lately found that the Nepali variety of Soy Bean, which yields well and compares favourably with the best variety on the English market in size and oil content, has the single disadvantage of a brown seed coat.

**Other Crops.**—A large number of other crops have received attention during the year and some of these are mentioned here to indicate the wide nature of the field awaiting investigation.

Woodhouse has studied the extent of cross-pollination in the genus Phaseolus in Bihar.

Howard has grown certain grams along pure lines and noted considerable variations in their value, both as regards yield and quality. He considers that this crop presents a considerable margin within which improvements may be effected.

Burns has completed his survey of the peas and beans in the Bombay Presidency.

The expansion of the groundnut area continues, some 1,200,000 acres being under the crop. It has been justly pointed out that this extension has been coincident with the growth of the Agricultural Department in India, for every Provincial Department has been active in testing the kinds collected from all quarters of the globe, largely through the agency of the Palur farm in Madras, and distributing such forms as appeared to be suited to its own soil and climate. This distribution still continues on a large scale and several new tracts have been opened during the year.

Oil seeds are receiving a certain amount of attention. At Pusa the study of their pollination is being taken in hand. In Bengal, Hector has established pure lines of the Brassicas of the Province. He has collected and classified the tils and studied the amount of cross-pollination in the fields. Nothing that the oil content of the local kinds was uniformly inferior, he has introduced the best forms from other parts of India with a view to comparative growth and the improvement of the staple. Evans in the Central Provinces has been successful in the selection of better varieties and arrangements have been made for the pure growth of better class tils in 47 villages of Hoshangabad.

Howard has suggested that the present poor growth of indigo in Bihar is largely traceable to inferior cultivation and waterlogging. As

the result of trials at Pusa, he proposes wheat as a cover crop, care being taken to select an early, rapidly maturing variety. The question of seed farms having become urgent because of the increasing difficulty of obtaining good seed, he suggests Cawnpore or South Bihar as suitable places for the establishment of these.

The Howards have continued their study of the botanical characters of fibre plants.

Woodhouse has selected out a number of varieties of *Setaria italica* in Bihar and grown them on in pure lines.

Graham has made a survey of the Cucurbitaceæ of the Central Provinces. He has specially studied certain genera and separated out a number of distinct varieties.

Barber has made a study of the peppers of South India and arranged his collection of 1,143 sheets under a series of types. As remarked by Hooker in the Flora of British India, the genus requires revision by botanists in the field. This has now been largely accomplished and a summary note has been drawn up and placed in the Herbarium at Coimbatore for the guidance of authors of the forthcoming Flora of Madras. Several new species have been accurately studied and described, some of them being considered to be of high commercial value.

The flax experiments at Dhooriah by Vandekerkhove have been successful, showing a large profit, but the cultivation and preparation require a considerable amount of expert knowledge.

Hector has studied the Capsicums in Bengal and has demonstrated cross-pollination in the fields. The classification of those in the Central Provinces has been completed by Graham, specially pungent forms have been selected and largely distributed by seed.

**Fruit-culture.**—Fruit trees have received some attention. A fruit garden has been established near Quetta but, as the results will take some years to materialise, an older garden has been taken over in Quetta itself. Here various experiments are being conducted. Howard considers that the best form of packing is in chip and board boxes the materials of which are imported from Glasgow. The mango continues to receive a great deal of attention, especially in Bombay, and Hartless of the Saharanpur gardens has furnished a useful scheme for their preliminary classifications.

Work of great promise is being carried on by Robertson Brown in the Tarnab farm near Peshawar in fruit-culture. The introduction of ring-budding has been a great success and the plants so prepared from superior varieties of peaches, with large, well-flavoured fruit, are being readily taken up in large numbers by the local cultivators. The best method of packing these superior peaches has been decided on and it is expected that a large export trade will result.

**Root Development.**—Closely connected with the working of the soil is the effect of this on root development, but little account seems to be taken of the great diversity in the root systems of different kinds of crops. Parr has shown by experiment that, by deeper planting maize plants at Aligarh and earthing up a distinctly larger yield can be obtained and this method is being taken up by the neighbouring cultivators. Burns has continued his studies of the root systems of fruit-bearing trees in Bombay. Howard has made the interesting observation that, when the roots of banyans are severed, they not infrequently reunite by a process of natural root-grafting.

Barber in Coimbatore has made a survey of the root systems of the crops growing on the farm in mixed black cotton and red soil. Each system has been carefully dissected out, noted and photographed to scale, and interesting facts have been brought to light concerning the duration of crops. A special study was made of the species of cottons growing in the tract and it was recorded that Cambodia was capable of developing a root system suggesting that it might be grown in many parts of the Presidency without irrigation. The root systems of the tamarind, nim, portia (*Thespesia populnea*), babul and agathi (*Sesbania grandiflora*) received special attention with regard to their influence on the crops around them.

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## Part II.—FOREST BOTANY.

BY

R. N. PARKER, F.C.H.,
*Forest Botanist.*

**Œcology of sal.**—Experiments carried out during the year by the Forest Botanist in growing *sál* seedlings (*a*) *in situ* in typical local grasslands and (*b*) at Dehra Dun in large flower-pots in soil collected from the same grasslands have corroborated the fact mentioned in previous reports that the dominant species of grass is an accurate indicator of the local conditions of soil and of the suitability or otherwise of the area occupied by these grasses for the growth of different forest trees. The work done up to date shows that, for the successful growth of *sál* seedlings, the soil must be well aërated and must at the same time be capable of retaining not less than 10 per cent. of moisture throughout the hot season. In a badly aërated soil the percentage of germination of *sál* is lower and the percentage of deaths during the rains is higher than in a well-aërated soil. In addition to this, the average length of root of one-year-old *sál*

seedlings is 12″ and 30″ in badly and well-aërated soils, respectively. Thus the former plants are also more subject to the injurious action of drought, seeing that their roots are situated in the upper layer of soil which dries out rapidly in the hot season. An interesting fact brought out in the experiments is that by simple mechanical pressure (even when the soil is practically dry), such as would be caused by the tread of grazing animals, a soil known to be suitable for the growth of *sál* can be rendered totally unsuitable on account of its bad aëration.

An important point investigated during the year was that of the heavy mortality of *sál* seedlings which usually occurs in the local *sál* forests during the rains, in July-August. The experiments carried out clearly showed that the responsible factor was not shade, *i.e.*, an insufficient intensity of light. The light intensity in the forests when the mortality ranged from 80—90 per cent. of deaths was 0·02 to 0·05. Under artificial shades, on the other hand, *sál* seedlings have been grown successfully with a light intensity as low as 0·007, the mortality during the rains being only 20 per cent. So far as the work has gone at present it indicates that the dominant factor here responsible is bad soil aëration which is brought about chiefly by (*a*) the shade in the forest preventing free air-circulation and thus decreasing the evaporation of water from the soil and (*b*) a high percentage of humus in the surface soil which greatly increases its capacity for holding water. A set of experiments has been designed which should further elucidate this point next year and it has been considered advisable to defer publication until these results are available.

**Forest grasses.**—The study of the species mentioned in last year's report was continued while the work undertaken in collaboration with Mr. Raitt on those species likely to be valuable for paper-pulp was completed and the results of the latter are now in the press. The following widely distributed and gregarious species have all been found to constitute a first class material for the manufacture of paper-pulp and they can all be treated either separately or in mixture without reducing the value of the product:—

*Saccharum spontaneum*, Linn.
,, *arundinaceum*, Retz.
,, *Munja*, Roxb.
,, *Narenga*, Wall.
*Anthistiria gigantea*, Cav.
*Arundo Donax*, Linn.
*Phragmites Karka*, Trin.

The following species, although somewhat inferior in quality and strength of fibre to the above, have been found to be admissible

in moderate quantity with them without material prejudice to the yield and quality of the pulp:—

*Saccharum fuscum*, Roxb.
*Andropogon intermedius*, Br.
*Vetivera zizanioides*, Stapf.
*Andropogon Nardus*, Linn.
*Erianthus Ravennæ*, Beauv.

A negative result of considerable importance is that the very common *Andropogon contortus*, Linn., the well-known Spear grass of the plains, is of no value and is quite inadmissible in mixture. It has been found that the maximum yield of cellulose is obtained if the grasses are cropped when flowering and as the culms of some of the species require more than one year to attain maturity and flower, this means that they must be worked on a rotation. One species, *viz.*, *Saccharum arundinaceum*, Retz., the culms of which require 3 or 4 years to attain maturity, has been found to give an average annual yield of 14 tons of dry material per acre per annum which is believed to be the highest yield of any pulp-yielding species. (*Hedychium coronarium* has been recently reported to give 10 tons per acre per annum which is apparently the next highest yield.) Another of the species dealt with (*Anthistiria gigantea*) has been found to yield a pulp of quite exceptionally high quality.

**Local Forest Floras.**—The Forest Botanist prepared a detailed scheme for the preparation of descriptive lists in all provinces for the consideration of the Board of Forestry which met at Dehra Dun during the year. On this note the Board passed the following resolutions:—

(1) That detailed Forest Floras are useful for purposes of reference and that their ultimate publication is an object which should be kept steadily in view.

(2) That the preparation of detailed Floras is not of such urgent importance at the present time as is preparation of descriptive lists.

(3) That the scope and general character of the descriptive lists as detailed in the note are generally suitable.

(4) That the preparation of descriptive lists should be undertaken in the various provinces as soon as circumstances permit.

There is thus good reason to believe that this important work will now be systematically and energetically taken in hand.

A list of trees, shrubs, etc., recorded from Burma with vernacular names was issued by Mr. Lace, Chief Conservator of Forests, during the year.

*List of papers on Economic Botany.*


ANSTEAD, R. D. . Hevea Rubber in Southern India. (*Agri. Jour. of India, vii, 257, 1912.*)

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BEALE, R. . . Studies in Vegetable gland tissues. I. (*Poona Agri. Col. Magazine, iv, 267, 1913.*)

BOMBAY DEPARTMENT OF AGRICULTURE. Treatment of a Mango Plantation. (*Agri. and Co-operative Gazette, viii, No. 10, 1912.*)

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CLOUSTON, D. . . Transplantation of Rice in Chhatisgarh. (*Agri. and Co-operative Gazette, Central Provinces, ix, No. 5, 1913.*)

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GRAHAM, R. J. D. . Robber Plants. (*Agri. Co-operative Gazette, Central Provinces, ix, 1913.*)

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HECTOR, G. P. . . Notes on Pollination and Cross-Fertilization in the Common Rice Plant, *Oryza Sativa.* [*Mem. of the Dept. of Agri. in India (Bot. Series), vi, No. 1.*]

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,, ,, . . *Burmese Kaing Grass.* (*Ind. For., October 1912.*)

,, ,, . . *Useful Exotics in Indian Forests.* (*Ind. For. Rec., iv, 3, January 1913.*)

,, ,, . . *Albizzia Lathamii,* Hole. (*Ind. For. Rec., iv, 4, January 1913.*)

,, ,, . . *Note on the chief Fodder Grasses of Indian Forests.* (*Ind. For., February 1913.*)

,, ,, . . *A Notorious Indian Fodder Grass.* (*Ind. For., June 1913.*)

HOPE, G. D. . . A Method of renovating tea bushes by pruning. (*Quarterly Journal of the Indian Tea Association, 57, 1912.*)

,, ,, . . The Value of Leguminous trees in tea gardens. (*Quarterly Journal of the Indian Tea Association, 64, 1912.*)

HOPE, G. D., & TUNSTALL, A. C. Green Manuring, Parts I and II. (*Quarterly Journal of the Indian Tea Association, 99, 1912, and 22, 1913.*)

HOWARD, A. . . Natural Root-grafting. (*Agri. Jour. of India, viii, 185, 1913.*)

,, ,, . . Some Aspects of the Agricultural Development of Bihar. (*Bull. No. 33, Agri. Res. Instt., Pusa, 1913.*)

HOWARD, A., & HOWARD, G. L. C. The Improvement of Indian Wheat. (*Agri. Jour. of India, viii, 7, 1913.*)

HOWARD, A., & HOWARD, G. L. C. The Improvement of Crops. (*Agri. Jour. of India, viii, 111, 1913.*)

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| KULKARNI, K. D. | . Notes on the Cottons of Gujerat. (*Poona Agri. College Magazine, iv, 23 and 111, 1912.*) |
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| KULKARNI, L. B. | . Experimental Fig-drying at Saswad. (*Agri. Jour. of India, viii, 83, 1913.*) |
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| LEAKE, H. M., & RAM PRASAD. | Wheat Experiments on the Botanical Area, Cawnpore, and their bearing on Wheat Cultivation in United Provinces. (*Bull. 31, Agri. Res. Instt. Pusa, 1913.*) |
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| MAHOMED AMIN KHAN | Ring-budding. (*Agri. Jour. of India, viii, 74, 1913.*) |
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| PARKER, R. N. | . *Eucalyptus in N. W. India.* (*Ind. For., February 1913.*) |

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PATWARDHAN, G. B. . The Experimental Renovation of Orange Plantation. (*Poona Agri. College Magazine, iv, 172, 1913.*)

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PATWARDHAN, V. G. . 'Pan' Cultivation at Ramtek in Nagpur. (*Ibd., iv, 36, 1912.*)

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# BOTANY.

## III.—MYCOLOGY.

BY

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*Imperial Mycologist.*

### I.—Plant Pathology.

**Agricultural Research Institute, Pusa.**—The following is an account of the chief diseases of plants investigated at Pusa during the year.

**Rice diseases.**—A disease of inundated rice, of a very serious nature, has broken out in the deltaic districts of Eastern Bengal, where it is locally known as *ufra*. Much time was given to its investigation. It has been found to be caused by a minute parasitic nematode worm, of the genus *Tylenchus*. Though not mycological, it is referred to here, as, in the absence of any agricultural Helminthologist in India, its further investigation has been taken up by the writer. The parasite, a hitherto undescribed species, attacks especially the deep-water winter rice so extensively grown in the area referred to, and the intensity of the attack is such that affected fields are frequently not considered worth harvesting. In the backward state of agricultural information in Eastern Bengal, it is difficult to arrive at even an approximate estimate of the losses, but they are undoubtedly very heavy and there is evidence that the disease is spreading. The parasite is allied to two of the worst worm parasites of crops known, *Tylenchus tritici* and *T. dipsaci*. It appears to be strictly parasitic on rice, being unable to grow and multiply in the absence of living rice plants. It feeds by piercing the epidermis of those parts of the plant where the outer wall is unthickened and not silicified and, consequently, is restricted to certain definite parts of the plant: the apex of the shoot, the young leaves, above the upper stem nodes, and the young ear being the chief. The result of its attacks is to prevent the ear from maturing properly and there is total or partial loss of the grain. It passes the period between successive crops coiled up, in a resting condition, in the stubble and can stand drying in this condition for over a year. No evidence has, as yet, been obtained that it hibernates in the soil; if subsequent work confirms this, there is a good

prospect of being able to fight it by destroying all stubble left after harvest, and experiments in this direction are being carried out.

The chief fungus diseases of rice studied were bunt, caused by *Tilletia horrida* Tak., false smut caused by *Ustilaginoidea virens* (Cke.) Tak. and a disease caused by *Sclerotium Oryzæ* Catt. Accounts of these diseases have been published since the close of the year under review.

**Root rot of various crops.**—A description of the morphology and parasitism of two species of the form genus *Rhizoctonia*, soil parasites which attack the underground parts of several crops, was published. Cotton, jute, groundnut, cowpea, potatoes and sesamum are amongst its victims. More recently, it has been found to cause opium blight and to damage lucerne. The published investigations deal with two species, *R. Solani* Kühn on jute, cotton, potato, groundnut and cowpea and *R. violacea* Tul. on groundnut and cowpea. The latter is shown to be an imperfect stage of the basidiomycete *Corticium vagum* B. & C. Details of their morphological characters in culture and their behaviour as parasites, are given.

**Phytophthora investigations.**—Two species of this most destructive genus of fungus parasites, *Ph. parasitica* Dastur and *Ph. Colocasiæ* Rac., have been under study, and the results were published. *Ph. parasitica* causes a disease of young castor plants, being the most serious disease of the crop known. It was obtained in pure culture and this permitted of a very full study of its characters and parasitism. The chief interest centres in the discovery of a new type of reproduction, a discovery which was anticipated by a British Mycologist, working with an allied species, shortly before the publication of the paper. A very complete series of inoculation experiments was carried out, potato, tomato, brinjal, til and several other plants proving susceptible to attack.

*Ph. Colocasiæ* attacks the country vegetable, *Colocasia antiquorum*, and, under certain conditions, causes much damage both to the growing crop and, subsequently, to the stored corms. The intensity of the attack is closely dependent on the character of the monsoon, being worst in wet years. The parasite was cultivated artificially and a large series of inoculation experiments carried out, which showed that it has a very restricted range of victims. It possesses the same remarkable type of reproduction as *Ph. parasitica*.

More recently *Ph. infestans*, the cause of the well-known potato blight, has been under study, a serious outbreak having occurred in Bihar and Bengal last year. It has also been obtained in pure culture and it is hoped to get some light on the reason why it is so rarely found in the hotter parts of India.

**Sugarcane diseases.**—The progress in the investigation of several diseases of this crop is referred to in the Pusa Annual Report for 1911-12.

The work has extended over a number of years, owing to difficulties encountered in carrying on field experiments. It has been so far completed as to allow of the preparation of two Memoirs now in the press, one on red rot (caused by *Colletotrichum falcatum* Went), and a second on some new sugarcane diseases. The chief points elucidated are the channels of natural infection of the crop, in some of the more important stem diseases, and the methods of control to be adopted in practice. These will be referred to more fully in the next report.

**Wheat rust.**—A severe attack of wheat rust, the first for a number of years, occurred in the Central Provinces in 1912. It was found that orange rust (*Puccinia triticina*) was responsible for much of the damage, though in ordinary years scarce in that part of India. Black rust (*P. graminis*) was also severe. Hence, in breeding rust-resistant wheats, the behaviour to these two rusts must be chiefly considered and, as orange rust may be absent in ordinary years, it may be necessary to carry out some of the work in parts of India where orange rust occurs annually.

**Anthracnose of sisal hemp.**—This was definitely proved to be due to the fungus *Colletotrichum Agaves* Cav. previously suspected to be its cause. It infects various species of *Agave* readily, and produces a characteristic leaf disease. Collecting and burning diseased leaves, and spraying with Bordeaux mixture, are recommended as measures likely to check the disease.

**Damping off.**—This seedling disease, caused by *Pythium de Baryanum* Hesse, was not previously reported from Asia, but has been found to occur occasionally at Pusa. It was studied, and some doubtful points in its morphology cleared up. In temperate countries it causes a good deal of loss, but does not appear to be a serious danger in India.

**Cereal downy Mildews.**—These diseases, caused by members of the genus *Sclerospora*, appear to be of greater importance in India than elsewhere. Maize, several of the more important millets and a fodder grass, are amongst the crops affected. The maize mildew appeared at Pusa for the first time last year, and is probably a recent importation from Java, where it has been known since 1897. It has not yet been found in any other country, but in Java causes much loss. From its investigation at Pusa, it was found to be closely allied to the form on jowar (*Andropogon Sorghum*) and to be a true *Sclerospora*, not a *Peronospora* as stated by investigators in Java. It was also shown that the resting-spore stage described in Java, by which the disease was supposed to be perpetuated, had in reality nothing to do with the fungus, being merely the cystic stage of a Protozoon. Nothing is known of the life-history of the *Sclerosporas*, and observations are being continued in the hope of determining how the parasite persists from one season to the next. Until this is decided, it is not possible to find a rational method of con-

trol, and the only measure that can be recommended is to pull out and destroy all diseased plants, which can only be done in mild attacks.

Mr. Kulkarni, Mycological Assistant, Bombay Department of Agriculture, has given reasons for separating the *Sclerospora* on jowar from that on bajri (*Pennisetum typhoideum*) as a distinct variety, to which he has given the name *Sc. graminicola* var. *Andropogonis Sorghi*. He has also furnished useful notes on the field characters of these mildews.

**Indigo blight.**—This obscure disease has been under study for some time, but no parasitic organism has been found constantly associated with it and it is considered to be non-fungal in origin. A considerable number of different organisms, mostly of the class known as weak parasites, were isolated from individual plants, in various stages of the disease, but none proved capable of reproducing it. The mycological side of the enquiry has, therefore, been abandoned.

**Miscellaneous.**—Notes are given in the Annual Report of the Mycological Section, Pusa, for 1911-12, on a number of other diseases of plants studied during that period. The more important were cotton wilt, anthracnose of plantains, foot rot of papaya, lucerne and cauliflower mildews and a number of forest tree diseases. The successful treatment of oat smut by formalin steeping is recorded, and notes are given on the areca palm disease in North-Eastern India, believed to be caused by *Fomes lucidus* (Leys.) Fr.

**Provincial Departments of Agriculture.**—The following are the chief items of mycological work carried out by Provincial Departments of Agriculture and referred to in the reports published during the year.

**Madras.**—Mr. McRae continued the campaign against bud-rot of palms (caused by *Pythium palmivorum* Bult.) in the Godavari and Kistna Districts. Some extensions of the disease outside the area covered by the operations were discovered and dealt with. In Kistna there is a distinct decrease in the area affected, as a result of the work, but the checking of extension in the upland forest area is a serious problem. In Godavari the area remains practically the same and there is no decrease in the number of trees cut periodically. In a paper published in the *Agricultural Journal of India*, Mr. McRae calls attention to the danger of allowing palms, which have spots caused by the parasite on the expanded leaves, to remain uncut. The fungus in this position is exposed to wind dissemination and each such tree serves as a centre of spread to surrounding palms. Fortunately the number of cases in which the parasite attacks the leaf blades is small. As there is a difficulty in inducing the ryots to allow these to be cut, a proposal has been made to employ some form of compulsion.

Mr. McRae carried out extensive experiments in spraying areca palms, affected with the *Koleroga* or *Mahali* disease (caused by *Phytophthora omnivora* var. *Arecæ* Coleman), in South Malabar, with such success that the owners have asked that the work should be continued. The increased profit per 100 trees sprayed was over Rs. 20.

A bud-rot of coconuts was reported from Malabar. It was at first believed to be identical with that of Cuba and the West Indies, the cause of which is *Bacillus coli*, but recent reports indicate that it is due to *Pythium palmivorum*. It is, at present, impossible to gauge the importance of this outbreak, but the chief fear which has always been felt by those responsible for the work against this parasite in Madras, has been that it should develop with virulence in the enormously valuable coconut plantations of the West Coast.

Other work in Madras included unsuccessful attempts to secure inoculations with the false smut of paddy [*Ustilaginoidea virens* (Cke.) Tak.], stringent selection of the sugarcane crop at Samalkota with a view to checking red rot, and the study of several diseases of various crops.

**Mysore.**—Dr. Coleman continued work in connection with the *Koleroga* disease of areca palms, and the parasitism of *Fomes lucidus* on the same tree.

**Bombay.**—Mr. Ajrekar published a note on the rust of castor (*Melampsorella Ricini* de Toni). Work in connection with the control of *Koleroga* of areca palms and red rot of sugarcane was continued.

**Central Provinces.**—Work was confined to observations on the behaviour of varieties of wheat to rust, with a view to securing rust-resisting strains, and further tests of the immunity of buri cotton to wilt. The latter were eminently satisfactory, almost complete immunity being shown, even when planted in fields very severely infested with wilt. As the variety yields the cultivator about Rs. 40 less per acre than the cottons ordinarily grown, its use is likely to be restricted to wilt-infested areas.

**Bihar.**—Mr. Basu studied the outbreak of *Phytophthora infestans* on potato and has published a note on it since the close of the year under review.

**Burma.**—The anthracnose of cotton (caused by *Colletotrichum Gossypii* Southw.) was found on Pernambuco tree-cotton. A short note giving suggestions for its control was published as a departmental leaflet.

**Indian Tea Association.**—Mr. Tunstall has contributed a number of notes on tea diseases to the Association's Quarterly Journal. These deal chiefly with root diseases, the commonest being those caused by *Ustulina zonata* Lev., *Hymenochæte noxia* Berk. and *Botryodiplodia*

*Theobromæ* Pat. Besides the measures previously recommended for the check of these diseases, experiments were carried out with a new treatment, consisting in the application to the soil of ammonium sulphate and lime in equal parts, after removing all dead roots. This results in the liberation of ammonia, which is stated to inhibit the growth of the parasite.

Of leaf diseases the chief referred to are blister blight, caused by *Exobasidium vexans* Mass., and copper blight, caused by *Lœstadia Theæ* Rac. Blister blight was observed in Darjeeling and North-East Assam. It has been found to persist through the cold weather on old nurseries, seed gardens and abandoned tea, and it is recommended that attention should be directed to preventing infection from these sources. None of the plucking area should be left unpruned and no abandoned tea or old nurseries should be kept; all seed gardens should be sprayed with Bordeaux mixture; and planters should unite so as to secure concerted action in stamping out the disease. Copper blight is said to be on the increase, but to cause comparatively little damage at present.

## II.—Systematic Mycology.

There is little to record under this head during the year. A few new species have been described from India by Saccardo and Sydow. Dietel points out that the common Himalayan rust of wild vines cannot be identified with *Phakopsora Vitis* Syd., but is a distinct species, which he has named *Phakopsora cronartiiformis* (Barcl.) Diet. Theissen has commenced the publication of a compilation, giving a list of the Fungi of India, in the Journal of the Bombay Natural History Society.

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*List of Publications.*


Ajrekar, S. L. . . The Castor Rust (? *Melampsorella Ricini* de Toni). (*Journ. Bombay Nat. Hist. Soc., xxi, p. 1092, 1912.*)

Annual Reports of the Agricultural Research Institute and College, Pusa, and of the Provincial Departments of Agriculture.

Butler, E. J. . . Ufra disease of Rice. (*Bull. of the Bureau of Agric., Intell. and Plant Diseases, 3rd year, No. 7, p. 1661, 1912.*)

,, ,, . . Pythium de Baryanum Hesse. (*Mem. Dept. of Agri., India, Bot. Ser. V, No. 5, 1913.*)

,, ,, . . The downy mildew of Maize [*Sclerospora Maydis.* (Rac.). Butl.] (*Ibid.*)

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| BUTLER, E. J. . | . Note on the investigation of diseased conditions of the Indigo crop in 1911-1912. (*Read at the General Meeting of the Bihar Planters' Association, Jan. 29th, 1913.*) |
| BUTLER, E. J., & KULKARNI, G. S. | Colocasia Blight, caused by *Phytophthora Colocasiæ* Rac. (*Mem. Dept. of Agric., India, Bot. Ser. V, No. 5, 1913.*) |
| DASTUR, J. F. . | . On *Phytophora parasitica* nov. spec., a new disease of the Castor oil plant. (*Mem. Dept. of Agric., India, Bot. Ser. V, No. 4, 1913.*) |
| DEPARTMENT OF AGRICULTURE, BURMA. | Anthracnose (a disease of the Cotton plant). *Cultivators' Leaflet No. 38, 1912.*) |
| DIETEL, P. . | . Eine Bemerkung über *Uredo cronartiiformis* Barcl. (*Ann. Mycol., x, p. 385, 1912.*) |
| KULKARNI, G. S. | . Observations on the downy mildew [*Sclerospora graminicola* (Sacc.) Schroet.] of Bajri and Jowar. (*Mem. Dept. of Agric., India, Bot. Ser. V, No. 5, 1913.*) |
| MCRAE, W. . | . Rows of spots on the leaves of Palmyra palms, caused by the bud rot fungus, *Pythium palmivorum* Butl. (*Agric. Journ., India, vii, p. 272, 1912.*) |
| SACCARDO, P. A. | . Notæ mycologiæ. (*Ann. Mycol., xi, p. 14, 1913.*) |
| SHAW, F. J. F. . | . The morphology and parasitism of *Rhizoctonia*. (*Mem. Dept. of Agric., India, Bot. Ser. IV, No. 6, 1912.*) |
| ,, ,, | . Anthracnose of Sisal hemp. (*Agric. Journ., India, viii, p. 65, 1913.*) |
| SYDOW, H. & P. | . Novæ fungorum species. (*Ann. Mycol., x, p. 405, 1912.*) |
| THEISSEN, F. . | . The fungi of India. (*Journ. Bombay Nat. Hist. Soc., xvi, p. 1273, 1912, and xxii, p. 144, 1913.*) |
| TUNSTALL, A. C. | . Notes (in *Quart. Journ. of the Indian Tea Assoc., 1912 and 1913*). |

## IV.—AGRICULTURAL BACTERIOLOGY.

BY

C. M. HUTCHINSON, B.A.,
*Imperial Agricultural Bacteriologist.*

**Agricultural Bacteriology.**—Nitrogen supply in the soil as affected by intervention of bacteria has been the principal subject of enquiry; in the previous year attention was confined to the conditions under which organic nitrogen of manures and residues was converted into ammonia and nitrates; this line of enquiry affords sufficient work to occupy the whole time of any establishment for many years, but it has been considered advisable to add to it an investigation of the natural conditions under which nitrogen is taken from the air and added to the soil in this country. This if carried out thoroughly would also involve a very large amount of work, but it seems advisable in dealing with such a question as soil bacteriology in this country, where no work on this subject has been carried out before, to make preliminary enquiries, however superficial, on similar important questions, in order to gain some idea of the most useful direction in which to pursue the subject more fully. This is the more necessary on account of the still early stage of development of soil bacteriology as a science, and the fact that many fundamental theories connecting bacterial action with soil fertility have not yet been accepted as axiomatic. It is perhaps unnecessary to emphasize the importance of the question of nitrogen fixation, but it may be pointed out that there is very good reason for supposing that upon this depends the ultimate prosperity of a country, the mineral wealth of which not being commensurate with its agricultural area and population debars it from the purchase of adequate supplies of nitrogen from external sources. At the present time the need of nitrogen in India is becoming increasingly greater owing to the introduction of intensive cultivation, although up till now the soils of this country as a whole have been preserved from undue depletion, by the generally superficial and extensive nature of the cultivation employed, which has prevented large crops from being taken off the land, after the reduction of the original virgin soil to the normal level of fertility by the growth of crops. At the same time deportation of nitrogen in the form of produce exported from areas in which it was grown has not been excessive, and in the case of rice much fertilization of the soil takes place by deposition of organic matter carried down from jungle tracts by the irrigation water.

Nowadays, however, this state of affairs is being rapidly altered owing to the expansion of Indian trade, which not only transports food stuffs from agricultural districts to feed the increasingly large populations of cities, but carries enormous quantities of produce out of the country, including not only cereals, oilseeds and fibres, but bones and hides, which represent nitrogen collected from very extensive areas of land. If now, in addition to this constant drain upon the nitrogen resources of the soil, intensive cultivation is introduced, meaning the more rapid conversion of non-available plant food, especially nitrogen, into the available condition, depletion will certainly follow, differing in intensity from such a result in temperate climate as the average soil temperature in India differs from that in Europe, but in an even higher degree. This difference due to temperature has been observed and measured in this laboratory as affecting ammonification, nitrification, and the formation of carbon dioxide by oxidation of the organic matter of the soil, and is not one of a slightly higher degree, but may easily attain to an increase in rate of one hundred per cent. or more; the concurrent loss of nitrogen is not to be measured, therefore, only by the increased crops taken off the land, but by losses in the form of ammonia and of nitrate washed out during the rains from fallows in well drained areas.

A further point must not be overlooked; on the credit side of the nitrogen account must be placed the addition of this element to the soil through the intervention not only of leguminous plants but of nitrogen fixing members of the soil flora such as Azotobacter and Clostridium; the physiological activity of these organisms, however, is strictly limited by soil conditions, and especially in the case of the former by the supply of carbohydrate food, so that should intensive cultivation, carried out without regard to this aspect of the case, lower the supply of organic matter beyond the optimum point for nitrogen fixation by the above-mentioned organisms, this source of nitrogen would be cut off, and the discrepancy already existing between the two sides of the account would be further increased, probably in geometric proportion.

During the past year Azotobacter has been found in all Indian soils examined, including those of such widely differing character as may be found in Sind, Nagpur, and Assam; pure cultures of *A. Chroococcum* from such various sources exhibited nitrogen fixing power very similar to that recorded from European strains, its physiological activity depending upon appropriate supplies of water, air, lime, and especially of carbohydrate food. It is intended to carry out a general survey of Indian soils to get some idea of the distribution of this and similar organisms and the conditions under which they may most readily carry on nitrogen fixation in these soils.

The green manuring experiment begun in collaboration with the Imperial Agriculturist during the previous year was carried on and will continue in 1913-14. The successful use of a green manure crop was found to depend almost entirely upon the incidence of rainfall succeeding the burying of the crop, partly owing to the loss of soil moisture by transpiration during the growth of the green manure, and partly to the necessity for providing a considerable percentage of soil water to ensure the proper decomposition of the buried material. Further experiments during the current season include a special method of dealing with a green manure crop designed to avoid the loss due to want of sufficient soil moisture to ensure complete decomposition after burying; this method consists in hastening the initial stages of decomposition by steeping the cut crop in water and then fermenting it in heaps, under which conditions the less readily decomposed cell walls and lignified tissues are rapidly attacked by bacteria favoured by semi-anærobic conditions; the fermented material is then used in the same way as farmyard manure. The advantages of this method, in addition to the principal one of eliminating the uncertainty of the rainfall as a factor in decomposing the buried green material, include the possibility of applying the fermented manure at the best rate per acre and at the best time for producing its optimum manurial effects; at the same time it is not necessary to grow the green manure crop on the land which is to carry the "rabi" crop intended to benefit by its manurial effect; in some cases this might be of great advantage with regard to the depletion of the soil moisture consequent on transpiration during the period of growth of the green manure crop. This method of dealing with a green manure crop closely resembles the practice in indigo-growing districts of manuring tobacco and other soils with the refuse ("seet") from the indigo factory, which is obtained by steeping the cut indigo plant in water for some 24 hours and subsequently allowing the sodden plants to lie in heaps in which fermentation goes on; the rotted material thus produced is generally applied to tobacco lands, the rented value of which depends almost entirely upon the local availability of the indigo "seet."

The field experiments with green manure in 1912-13 included the growth of a "rabi" crop (wheat) on the experimental area. In no case was there any increase in yield from the green manured plots, and in many there was a decided falling off. There can be no doubt that this result was due to the failure of the generally expected rainfall in September and October (locally known as the "Hathia"), as it was found on examination that the buried stems of the green manure had failed to undergo complete decomposition.

Laboratory experiments showed that the nitrate formed from the buried plant tissues increased in amount up to the end of eight weeks from the time of turning into the soil, provided the water supply was

kept up to at least 16 per cent. of the soil weight, but after this period a steady diminution took place, so that after twelve weeks a smaller quantity of nitrate than that present at the end of the eighth week was invariably found. The cause of this loss was not discovered, although it may be conjectured that it was due to the demands of the soil organisms, for nitrogen, but its invariable occurrence is interesting as helping to explain the already well-known fact in field practice that too long an interval between the burial of a green manure and the sowing of the succeeding "rabi" crop is prejudicial to the latter so far as any improvement which may be expected from the use of the former is concerned.

The results of the first year's experiments on green manuring are being published in the form of a bulletin.

Further work on the occurrence of bacterio-toxins in soil, their relation to infertility and the action of tillage, drainage, and manurial application in neutralizing them, was carried out.

Biological analyses of various soils were made and further modifications of the method introduced; this subject is still in a very early stage of development, especially so far as interpretation of results is concerned, but it is hoped that further experience and modification of the method will lead to its successful application to the solution of various soil problems. At present it is possible to determine the optimum moisture content of a soil for certain biological processes necessary for fertility, to ascertain approximately the organic manures most suitable for application, with the important reservation that the sample experimented on may not be truly representative of the area to be treated; this source of error is greatly minimised by the use of large samples and the introduction of the method of using soil media in place of inoculating liquid media with small samples of soil; thus in the old method one gram of soil was generally used as inoculum and the biologic activity of the soil as a whole was judged therefrom. Whereas in the method now used, estimations of nitrifying and ammonifying capacity and efficiency, and general biologic activity, are made with samples varying from 400 grams to 1,200 grams.

## Special Enquiries.

**Sewage farms.**—At the request of the Principal of the Agricultural College, Nagpur, a series of investigations was commenced with a view to determining the effects of the application of the sewage upon the biological condition of the soils of the College farm. The writer visited Nagpur and inspected the farm soils and the sewage installation, and discussed with Mr. Allen and Mr. Plymen the general arrangement of the experimental plots to be put under treatment. An arrange-

ment was made for sending periodic samples to Pusa for examination and at the same time Mr. Plymen agreed to carry out chemical analyses to determine nitrate at Nagpur.

**Rice.**—An experiment was arranged to determine the effect of soil toxins upon the growth of the rice plant; this was in connection with the work of the Imperial Mycologist upon the "Ufra" disease of this crop, as it was considered possible that the incidence of this disease might depend upon adverse soil conditions. Rice was grown in pots in soil to which large quantities of mustard cake were added, it having been found that the initial stages of decomposition of this manure gives rise to bodies which are toxic to plants. The pots were arranged so that in one set lack of drainage should allow of accumulation of the toxins produced, whilst in the other continuous percolation removed them in solution. The results completely verified expectation, as not only was growth seriously interfered with in the undrained pots, but the root formation in the drained set showed that the toxins carried down by the percolating water had inhibited root growth in the lower soil, whereas in the undrained series more root development took place below than above. No symptoms of "Ufra" appeared, but Dr. Butler has now demonstrated conclusively the connection between this disease and the presence of nematodes in the plants, nor does it appear that soil conditions adverse to healthy growth render the latter more liable to attack. The investigations carried on by Mr. Harrison, Agricultural Chemist to Government of Madras, as to the nature of the changes taking place in soil under rice cultivation are referred to in the section dealing with Agricultural Chemistry.

**Indigo disease.**—Plants of Java variety were grown and kept under observation for symptoms of wilt in order to determine a possible bacteriological origin of this disease; this work will go on through the current season.

**Potato rot.**—An extensive series of investigations was carried out, mainly by Mr. N. V. Joshi, First Assistant to the Imperial Agricultural Bacteriologist, as to the cause responsible for the very common rotting of tubers in store. The Economic Botanist to the Government of Bihar and Orissa, at whose instance this work was undertaken, provided samples from various godowns in Bihar, and others were received from Poona. Two rotting bacteria were found to be present invariably and these appear to be normal in Indian soils. It was found that rotting could take place in presence of these bacteria either if the dry tubers suffered mechanical injury or if the uninjured tuber were kept under conditions in which its surface could remain moist for a few hours. Thus tubers stored in sand to keep out potato moth can be attacked, if the rotting organisms are present, either through bruising due to careless handling or by reason of the sand not being perfectly dry, or by contact

between a rotting potato exuding moisture and a sound one; this last possibility necessitates frequent examination of stored tubers and picking out of rotten ones. Various antiseptics were tried on a small scale, of which copper sulphate proved the best; this will be tested along with other preventive measures in the ensuing season.

*Publications.*

"*Drainage in Rice Soils*" by C. M. Hutchinson, Imperial Agricultural Bacteriologist. (*Agricultural Journal of India, Volume VIII, No. 1, January 1913.*)

# FORESTRY.

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## I.—SYLVICULTURE.

BY

EDWARD MARSDEN,
*Sylviculturist.*

**Statistical work in typical forest crops.**—The formation and measurement of sample plots, permanent and temporary, was continued and extended, 31 of the former and 8 of the latter being laid out in the United Provinces, and 31 of the former and 13 of the latter in the Punjab, a total of 62 permanent plots and 21 temporary plots during the year. In addition, 7 experimental plots were laid out in the Punjab with the object of ascertaining the most favourable conditions under which natural regeneration of *Pinus longifolia* could be obtained in practice. The species taken in hand were *Shorea robusta*, *Dalbergia Sissoo*, *Cedrus Deodara*, *Pinus longifolia*, *Pinus excelsa*, and *Quercus dilatata*.

In the permanent sample plots, the volume of timber standing is measured by means of dividing the total number of trees into inch-classes, and then by felling sample trees representative of three or four groups in which the inch-classes are incorporated. The plots will be remeasured every five years and will thus provide a basis for determining the rate of growth, the degree of density which produces the best results in the quality and quantity of timber formed, as well as forming a nucleus for the ultimate preparation of yield-tables. With the object of effecting a similarity and if possible an uniformity in the system adopted for measuring sample plots and typical trees, a note was published on the method used in the Sylviculture Branch at the Forest Research Institute for the collection and tabulation of statistical data. It is hoped that measurements carried out by Forest Officers working independently may follow the lines indicated, as only by an uniformity in the system of measurement and tabulation will it be possible to co-ordinate and compile all the figures collected.

**The Sal tree (Shorea robusta).**—A Bulletin was issued by Mr. Troup dealing with the causes and effects of the drought of 1907 and 1908 on the *sál* forests of the United Provinces, and in the course of his investigations it became clear that the subsoil is, in the case of *sál*, a

factor of preponderant importance, whole tracts of forests being destroyed or not according to the hygroscopicity of the subsoil. Experiments are in progress in the sylvicultural gardens to ascertain whether the presence of "nurses" may be of advantage to the young seedlings; the natural reproduction of this species continues to be under special investigation, and experimental plots have been under observation in numerous localities.

**Eucalyptus.**—The figures collected in the plantations of the Nilgiris show some astonishing results in the rate of growth of *Eucalyptus globulus* (Blue gum).

Mean annual increments of 527 cubic feet per acre per annum in the case of high forest and of 815 cubic feet in the case of 7-year-old coppice show that this species utilizes the productive capacity of the soil to the extent of forming in the case of coppice over 16 tons avoirdupois of wood in one year per acre. In the case of an average plantation, the initial expenditure amounts to Rs. 46 to Rs. 65 per acre (excluding value of land), the annually recurring costs to Re. 1 per acre, and the net receipts after deducting felling and carting charges to Rs. 70 per acre for 5-year-old crops, Rs. 331 for 15 year-old crops, and Rs. 592 for 25-year-old crops. These figures are calculated for coppice wood only, as the data available for high forest are insufficient to yield reliable results.

**In the sylvicultural gardens.**—Experiments are in progress for testing the regeneration of important species, both natural and artificial, in dense shade and in the open, and in moist patches; sowing combined with the cultivation of field crops is being tried; experiments in the best method and time of collection of seed and continued tests in the fertility of seed from trees of different sizes are in progress, as well as observations on the percentage of germinative capacity. Various methods of nursery treatment, the beds being sometimes weeded and sometimes unweeded, varieties of direct sowing and transplanting, some beds being irrigated and some left dry, are under trial.

**Developments in sylvicultural systems.**—The publication of "Der Blendersaumschlag Und Sein System" by Wagner marks an advance in the regulation of the method of management by purely sylvicultural considerations, which is the longest step in this direction taken for some time.

Mr. M. R. K. Jerram published a note on the Group System in Germany and its application to Indian forests with special reference to *Pinus longifolia* in the Himalayas; the revision of the Murree-Kahuta Working-Plan in the Rawalpindi Division is now under consideration, and the prescriptions of the new working-plan may be expected to show signs of the influence of this report.

Opinion in the Punjab has for some time been decided in favour of a definite change of sylvicultural treatment for the coniferous forests of the Himalayan hills. The selection system, the first attempt at any regular method of management, has been modified to a removal of the yield by selection in groups, and some Forest Officers now advocate the adoption of the group system in place of the selection system or any modification thereof. The question is a difficult one, and its ventilation by free discussion is to be desired. At the 1913 Punjab Forest Conference, an illuminating paper on the subject was read by Mr. B. O. Coventry, who also pointed out in his paper on the conditions necessary for obtaining natural regeneration in deodar forests:—"For practical purposes it may be assumed that the failure of natural regeneration is due to the accumulation of humus and other organic substances which have interfered with the proper aëration and drainage of the soil." It remains necessary to ascertain by experiment the best means of obtaining the desired conditions. The effect of drought and of the influence a seedling's position upon a steep or a very moderate slope may exercise upon its liability to prolonged cover by fallen snow appear also worth investigation.

The working-plans published during the year present no novel developments in the methods of management adopted.

**Xylia dolabriformis.**—A remarkable coincidence was the publication in the September 1912 number of the "Indian Forester" by Mr. R. S. Pearson of his observation that in the Western Ghats of Bombay, owing to continued protection from fire, moist deciduous forests were being replaced not at once by the true evergreen type, but by forests of which over 50 per cent. is made up of *Xylia dolabriformis;* while the next article was a statement from Mr. T. W. Forster that, in the Tharrawaddy Division of Lower Burma, fire protection and improvement fellings in combination had resulted in an almost regular forest of *Xylia dolabriformis* being formed from a mixed moist deciduous type.

*List of Indian Publications, 1912-13.*


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| AITCHISON, P. E. | . Working-plan for the Ankola-Kumta Coast Forests, Bombay Presidency. |
| ,, ,, | . Working-plan for the Sopinhosalli High Forests, Bombay Presidency. |
| BILLSON, H. G. | . Working-plan for the Municipal Forests, Mussooree, United Provinces. |
| FORSTER, T. W. | . Natural Regeneration of *Xylia dolabriformis* in Tharrawaddy, Burma. (*Ind. For., xxxviii, 455.*) |

GONSALVES, A. F. . Working-plan for the Igatpuri and Sinnar (Part) Range Forests, Bombay Presidency.

GRIEVE, J. W. A. . Working-plan for the Darjeeling Forests, Bengal.

JACOB, W. R. LEG. Report on the Forests of Bhutan bordering on the Boundary of Eastern Bengal and Assam, 1912.

JERRAM, M. R. K. . Report on the Group System of Natural Regeneration in Germany and its application to Indian Forests.

LEETE, F. A. . . Pyinmana Forest Division: Teak and Bamboos in Burma. (*Ind. For., xxxviii, 355.*)

LUSHINGTON, P. M. Note on the Coppicing Powers of Babul. (*Ind. For., xxxviii, 392.*)

MILROY, A. J. W. . Report on the Forest Resources of the Abor Country.

PARKER, R. N. . . Eucalyptus in North-West India. (*Ind. For., xxxix, 81.*)

SCOT, I. S. . . Coppicing of Babul in Guntur District, Madras. (*Ind. For., xxxviii, 396.*)

TROUP, R. S. . A Note on the Blue Gum Plantations of the Nilgiris (*Eucalyptus globulus*). (*Ind. For. Rec., v, Pt. II.*)

,, ,, . . A Note on the Causes and Effects of the Drought of 1907 and 1908 on the *Sál* Forests of the United Provinces. (*For. Bull. No. 22, 1913.*)

,, ,, . . The Collection and Tabulation of Statistical Data in the Sylviculture Branch, Forest Research Institute, Dehra Dun.

WHITEHEAD, J. . Working-plan for the Forests of the Jhansi and Banda Districts, Bundelkhand Division, United Provinces.

## II.—ECONOMIC FOREST PRODUCTS.

BY

R. S. PEARSON, F.L.S.,
*Forest Economist.*

**Economic uses of *sal* timber.**—The enquiry into the uses, mechanical properties, seasoning qualities, outturn and prices of *sál* timber was completed during the year. It was found that though the durability of hill-grown *sál* is undoubtedly greater than that of the plains-grown varieties, their strength to withstand shearing, compression and transverse strain varies little. As regards the fissibility of the timber, coppice-grown varieties split more easily than those of seedling origin. The total annual outturn of *sál* timber was arrived at after considerable difficulty and was found to amount to 162,411 tons per annum of which 150,336 tons is obtained from Government Forests and the remainder from Native States and private lands. Of this total 38 per cent. is converted into railway sleepers, the remainder being used for construction and other purposes. As regards the price of *sál* timber it is a curious fact that though practically every species of timber has gone up in price during the last 20 years, as for instance that of teak, Deodar, Rosewood, etc., the price of *sál* sleepers has not advanced 10 per cent. during that period.

The results of the above enquiry are now being published, all points having been dealt with except those referring to the relative strength of timber cut at various periods of the year and the seasoning qualities of the same, the experiments in connection with which are not yet complete.

**Bamboos for paper pulp.**—The enquiry into the uses of bamboos for paper pulp was completed during the year and a report published on the subject. The idea of utilizing bamboos for pulp has of late been seriously considered by interested persons in India, so much so that one firm has been granted a concession to exploit bamboo from a forest in Bengal and another firm has applied for a similar concession in Burma and a third in Arakan. The industry, which is a new one, may in time develop into one of importance.

**Antiseptic treatment of timber.**—The enquiry as to the value of the antiseptic treatment of Indian timbers, with special reference to railway sleepers, was vigorously prosecuted during the year. The 2,929 Powellized sleepers of five different species of timber which were laid down as an experiment in the Sukkur, Quetta, Lakshar and Lucknow

sections of the line, about two years ago, were inspected and found to be doing well.

The 1,921 sleepers treated with *Avenarius Carbolineum* oil last year have now been laid down, with the exception of a small number still to be dealt with and which are destined to be laid in the line near Agra. The majority of sleepers treated with this oil, having been only recently put in the line, have not as yet been inspected, except those near Pyinmana in Burma.

During the year a third batch of sleepers, numbering 1,375 in all, were treated by a mixed impregnation method. This consisted in first forcing in a large quantity of a 2 per cent. solution of chloride of zinc and after the timber had time to dry, dipping them into a hot bath of green oil, the latter operation being carried out not only to preserve the wood, but also to prevent the salt from leaching out of the timber when exposed to excessive moisture. These sleepers are also being handed over to the Railway Board for laying in the open line.

A fourth batch of sleepers will be treated with Solignum and mineral oil, thus completing this enquiry, the only work remaining to be done being to periodically inspect the sleepers.

**Tea-boxes.**—A tour was made last year to enquire into the tea-box industry in Assam. One of the chief difficulties under which the tea-box saw-mills managers have to carry on their work is due to the impossibility of storing shooks against demand, owing to the deterioration of the timber and its liability to be attacked by borers. To overcome this difficulty experiments were carried out during the year at the Forest Research Institute, by treating the shooks with chloride of zinc, alum and copper sulphate solutions. It was found that the treated shooks affected the tea-lead with which they came in contact; this was overcome by either applying a coat of varnish to the inside of the shook or by placing brown paper between the lead and the shook or by using silverised paper instead of tea-lead. A further experiment is now being carried out in this connection with the co-operation of Mr. Blair, of the Surma Valley Saw-mills and an Assam tea-planter, by sending tea packed in treated shooks to Europe, with the object of ascertaining whether the tea is affected in any way. The other part of the enquiry consists in placing treated shooks in positions where they are liable to be attacked by insects. They have now been under observation for a year and so far they have not been damaged in any way.

**Gums, resins and oleo-resins.**—(*i*) A considerable amount of attention has been paid to the possibility of utilizing *Boswellia serrata* gum-resin. Experiments were carried out in order to ascertain the best methods of tapping the tree. These experiments were commenced last year, during the hot weather, very indifferent results being obtained; it was therefore considered necessary to try tapping in the cold weather.

A series of experiments were undertaken by the Divisional Forest Officers of Nimar and Melghat in the Central Provinces, by the Conservators of Forests in Gwalior and Kotah States and by the Forest Economist in the Siwaliks. It was found by all the officers in their various experiments that some trees yielded copious gum-resin while others yielded very little, the size and age of the tree having little to do with the yield obtained. It is proposed to carry out further experiments in this connection during the next cold weather in the Central Provinces in order to ascertain the best rotation for tapping, with special reference to the power of the tree to heal the wound caused by tapping it. The gum-resin of this tree was distilled by the Forest Chemist, turpentine, rosin, gum and an essential oil being prepared. These products were submitted to firms for valuation and the preliminary reports received justify further investigation being made.

(*ii*) A good deal of work was done in connection with the distillation of *Pinus longifolia* resin, resulting in the remodelling of the Government Rosin and Turpentine Factory at Bhowali.

(*iii*) The question of introducing into Europe the natural varnish obtained from *Melanorrhœa usitata* was under investigation, many firms having enquired about this commodity. The subject is still under investigation.

**Tan barks.**—The enquiry as to the possibility of utilizing certain tan barks for preparing tan extracts was continued and a good deal of information collected as to outturn, the Economist having carried out experiments in the Siwaliks to determine the yield of dry bark from *Terminalia tomentosa* and *Shorea robusta* trees of different girths. In the Central Provinces and in Sind the Conservators carried out extensive experiments to ascertain the yield of bark per acre of *Acacia arabica;* 30 tons of this bark have since been sent to the Raneegunge Tan Extract Factory for testing. The Divisional Forest Officer, Arakan, carried out similar experiments in Mangrove forests and felled a sample plot to ascertain the yield and cost of extraction of the bark, per acre.

**Fibres.**—Samples of fibre of *Bauhinia Vahlii, Helicteres Isora, Sterculia villosa, Trema orientalis, Urena lobata* and *Calotropis procera* were submitted to a home firm for valuation, some of the reports being encouraging. Enquiry was also made in this connection as to outturn and prices, while two Forest Officers, under the direction of the Conservator of Forests, Sind, carried out extremely interesting experiments with the object of determining the best methods of collecting and separating Calotropis fibre.

**Miscellaneous uses of woods.**—Samples have been supplied to firms for trial in connection with cement barrels, railway rolling stock, musical instruments, packing cases and for a variety of other purposes, the reports on which are awaited.

**Economic and wood museums.**—A considerable number of specimens were added to both museums, especially to the latter. A complete collection of specimens of teak from all forests of India and Burma was formed and also one of all timbers used for tea-boxes. A collection of large specimen planks representing the better known timber-species of commercial value is gradually being formed, valuable additions having been recently made to the collection.

**Timber and minor product specimens.**—A very large number of specimens, chiefly of timbers, were supplied by the Forest Department to various Government Departments, private persons and firms in India, Australia, America and Europe.

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*List of Publications and Articles on Forest Economic matters published during 1912-13.*


BENSON, H. K. . Chemical Treatment of Waste Wood Recovering Values of Low Grade Material. (*Scientific American, June 7th, 1913.*)

COOMBS, F. A., & HARRISON, R. G. The Mangrove Bark of North Queensland and the Manufacture of Mangrove Cutch. (*Journ. Soc. Chem. Ind., Vol. XXXI, 212.*)

DONALD, J. . . Notes on a Visit to a Rusha Oil Factory. (*Ind. For., Vol. XXXIX, 149.*)

DUCHESNE, MARTIN COLLIER. English Timber: Its Markets, Value and Production. (*Surveyor's Institution, Transactions, Vol. XLX, Part III.*)

GOVERNMENT OF MADRAS Report on the Proposed Acetone Factory.

GROOM, PERCY . . Resin Ducts of *Pinus Gerardiana* and *Pinus Khasya.*

HOLE, R. S. . . Different forms of Pyinkado. (*Ind. For., Vol. XXXVIII, 461.*)

KARA, S. . . Banana and its Fibres. (*Cap., Vol. L, No. 1237, p. 78.*)

MACMILLAN, H. R. . Pulp-wood. (*Dept. of the Interior Canada, Forestry Branch, Bull. No. 30.*)

MOOR, BARRINGTON . Turpentining in Forests under Management. (*Amer. Forestry, Vol. XIX, 219.*)

PAREY, E. J. . Turpentine Standards. (*Chemist Druggist, Vol. LXXXI, 1,700, 52.*)

PEARSON, R. S. . Note on the Utilization of Bamboos for the Manufacture of Paper-pulp. (*Ind. For. Rec., Vol. IV, Part V.*)

,, ,, . Note on "Ligno Protector" as a possible means of Preventing Timber from Splitting while Seasoning. (*For. Bull. No. 13.*)

,, ,, . Note on the Tea-box Industry in Assam. (*Ind. For. Rec., Vol. V, Part I.*)

,, ,, . Note on Technical Properties of Timber with special reference to the behaviour of *Cedrela Toona* while Seasoning. (*For. Bull. No. 15.*)

,, ,, . A Further Note on the Relative Strength of Natural and Plantation Grown Teak in Burma. (*For. Bull. No. 14.*)

,, ,, . . Note on the Economic Value of *Shorea robusta* (Sál). (*In the Press.*)

PERKIN, M. F. . Turpentine and Turpentine Substitutes. (*Oil and Col. Tr. Journ., Vol. XLIII, 708.*)

PETERS, E. W. . The Preservation of Mine Timbers. (*U. S. Dept. of Agr. Bull. No. 107.*)

PURAN SINGH . Note on the Distillation and Composition of Turpentine Oil from the Chir Resin and the Clarification of Indian Rosin. (*Ind. For. Rec., Vol. IV, Part I.*)

,, ,, . . Note on the Preparation of Tannin Extracts, with special reference to those prepared from the Bark of Mangrove (*Rhizophora mucronata*). (*Ind. For. Rec., Vol. III, Part IV.*)

,, ,, . . Memorandum on the Oil Value of some Forest Seeds. (*Ind. For., Vol. XXXIX, 279.*)

RAITT, W. . . Report on Bamboo Pulp as a Material for the Manufacture of Paper. (*Ind. For. Rec., Vol. III, Part III.*)

,, ,, . . Report on Savannah Grasses as Material for Production of Paper-pulp. (*In the Press.*)

RAO, M. RAMA . Memorandum on the Tea-chest Industry in Travancore. (*Ind. For., Vol. XXXIX, 5.*)

RODGER, A. . . Note on *Gmelina arborea* timber. (*For. Bull. No. 16.*)

,, ,, . . Note on *Pterocarpus marsupium* timber. (*For. Bull. No. 17.*)

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| RODGER, A. | . Note on *Terminalia tomentosa* timber. (*For. Bull. No. 18.*) |
| ,, ,, | . Note on *Lagerstræmia lanceolata* timber. (*For. Bull. No. 19.*) |
| ,, ,, | . Note on *Ougeinia dalbergioides* timber. (*For. Bull. No. 20.*) |
| ,, ,, | . Note on *Anogeissus latifolia* timber. (*For. Bull. No. 21.*) |
| SURFACE, HENRY E. | . Bibliography of the Pulp and Paper Industries. (*U. S. Dept. of Agr., For. Serv., Bull. No. 123.*) |
| TEESDALE, CLYDE H. | . The Absorption of Creosote by the Cell Walls of Wood. (*U. S. Dept. of Agr., For. Serv., Cir. No. 200.*) |
| WEISS, HOWARD F. | . Prolonging the life of Cross-ties. (*U. S. Dept. of Agr., For. Serv., Bull. No. 118.*) |
| WINSLOW, CHARLIE P. | Commercial Creosotes, with special reference to Protection of Wood from Decay. (*U. S. Dept. of Agr., For. Serv., Cir. No. 206.*) |
| ,, ,, | Condition of Experimental Chestnut Poles in the Warren-Buffalo and Poughkeepsie-Newton Square Lines after Five and Eight Years' Service. (*U. S. Dept. of Agr., For. Serv., Cir. No. 198.*) |

# ZOOLOGY.

## I.—GENERAL ZOOLOGY.

BY

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### *Introduction.*

In the past years it has been customary to include in the report on zoology a brief statement as to all work with a direct bearing on India carried out outside the Indian Museum. This work has been, for some years past, increasing in bulk, and I have no means of obtaining official information as to its scope and objects until the results are published. It seems better, therefore, to confine any statement regarding it to the bibliography of published works. The present report deals only with zoological work carried out in the Indian Museum during the financial year 1912-13.

### *I.—General Progress, Zoological Section, Indian Museum.*

The most important event of the year has been the occupation of the new laboratories and offices on the top of the main building facing Chowringhee. All the research collections that were in the old building, which has now been transferred entirely to the Geological Survey of India, have been removed and rearranged.

Opportunity was taken to sort out the whole of the unnamed marine material (except the Mollusca) into the proper classes and orders and in some cases families.

### *II.—Collections.*

Mr. Kemp's zoological collections from the Abor country and those of the Surgeon-Naturalist to the Indian Marine Survey have perhaps formed the most important additions of a general nature to the zoological collection. Another important collection, however, is that made by Mr. Gravely with the assistance of Mr. S. P. Agharkar of the Elphinstone College, Bombay, in the Western Ghats. In all these cases many new species have been or are now being described on the basis of the new

material, while important additions have also been made to our knowledge of the distribution of already-known animals.

Since Lord Carmichael came to Bengal he has employed collectors to obtain the insects and other small animals of Sikhim and the Darjiling district. With great generosity His Excellency has arranged to distribute the specimens thus obtained to museums in India, Australia and Great Britain. On the abolition of Mr. Paiva's former post, he appointed him as his private assistant in arranging for the naming and distribution of the specimens. When Mr. Paiva was reappointed on the Museum staff, it was arranged by the Superintendent that he should continue to devote a certain part of his time to His Excellency's collections, which are now attaining great dimensions, in consideration of the fact that the Museum is to be allowed to retain any specimens that are required. Mr. T. Southwell has presented a very large and valuable collection of Entozoa together with some interesting crustacea.

Large additions have also been made by exchange with various Museums abroad and we have to thank our Honorary Correspondents and others for valuable specimens far too numerous to be acknowledged here specifically. Full acknowledgment will be made in various papers on different groups to be published in the "Records of the Indian Museum."

In March 1912, the Government of India made a special grant of £250 for the purchase of Mr. E. Green's collection of moths from Ceylon. This collection will be considered in next year's report.

As has already been pointed out, a large part of our zoological collection has been rearranged during the year. With the exception of the molluscs, on which a great deal of work is being and still remains to be done, all groups may now be said to be accessible to the student.

Mr. F. H. Gravely submits the following report on the entomological collections:—

## Arachnida, Myriopoda, and Insecta.

### *Arachnida.*

"**Scorpionidea.**—Dr. Henderson has named the scorpions collected by the Abor Expedition. The scorpions which we sent to Dr. Penther have eventually been forwarded by him to Dr. Kraepelin, who has already named them. Most of these specimens are now on their way back to us, and the rest of our unnamed collection, as well as representatives of the named collection, have been sent direct to Dr. Kraepelin, who hopes to be able to return these specimens also before very long.

**Chernetidea.**—Mr. Elligsen has identified and returned our whole collection of Pseudoscorpions. Unfortunately his health broke down

shortly afterwards and he has not yet been able to publish his descriptions of the new species.

**Araneae.**—The spiders of the Abor Expedition have been sent to Dr. Banks for report. The rest of the collection has been arranged by Mr. Gravely in the room adjoining that in which it was previously kept, where it was impossible to give it adequate space. The identifications of all the named Mygalomorphae not seen by Mr. Hirst have been checked, and most of the Argyopidae have been named, as have also a few specimens belonging to other families. But it has not yet been possible to check and synonymise the determinations previously made in other families. A number of specimens have been added to the collection, especially in the family Argyopidae, for the males of the local species of which a special search is being made.

**Phalangidea.**—Dr. Rohwer continues to determine all Phalangids added to our collection.

**Acari.**—Professor Nuttall and Mr. Warburton continue to name ticks for us. Dr. N. Banks has the mites of the Abor Expedition.

*Myriopoda.*

**Scolopendridae.**—Several new species have been described by Mr. Gravely and added to the named collection.

**Symphyla.**—All our material has been sent to Mr. Bagnall for examination.

**Other forms.**—These are still being worked out by Dr. Silvestri.

*Insecta.*

**Thysanura.**—Dr. Silvestri is still working at this order for us.

**Collembola.**—Dr. Carpenter is working out the Collembola of the Abor Expedition.

**Darmaptera.**—Dr. Burr continues to identify all earwigs we are collecting.

**Orthoptera.**—Dr. Griffini has undertaken the report on the Abor Gryllacridae and Stenopelmatidae and has asked for the rest of our material in these families as well. This has been sent to him.

The Mantidae and Phasmidae of the Abor Expedition have been sent to Dr. Giglio-Tos and the Tettiginae of the expedition to Dr. Hancock. Mr. Leigh still has material of ours in connection with his work on the life histories of Mantidae and Phasmidae. The deaths of Mr. Kirby and Mr. Shelford have unfortunately brought to an end the work of these investigators on our collections.

**Termitidae.**—Dr. Silvestri still identifies termites for us.

**Mallophaga.**—Our material in this group is still in the hands of Professor V. L. Kellogg. We understand that he expects to return it to us very soon now.

**Odonata.**—Mr. Laidlaw is working out the dragon-flies of the Abor Expedition.

**Neuroptera (sensu lato).**—Nothing more has been received from Professor Needham as yet. The Neuroptera of the Abor Expedition have gone to Dr. Banks for identification.

**Trichoptera.**—Dr. Betten still has our unnamed Trichoptera.

**Hymenoptera.**—Dr. Rohwer has reported on the Hymenoptera Sessiliventres of the Abor Expedition and is now working out the rest of our material in this group; Mr. Claude Morley is still working out Hymenoptera Parasitica for us; Mr. Wheeler is working out our ants and has already sent in his account of the Abor collection.

**Coleoptera.**—Mr. Gravely has finished rearranging our Passalidae and his catalogue of them is in the press; Mr. Arrow is still working on our Dynastinae, Cetoninae and Rutelinae; and Dr. Gillett has undertaken the identification of our Coprinae. Dr. Horn still names Cicindelidae for us; M. Grouvelle is now dealing with our Paussidae, Rhysodidae, Nitidulidae, Trogositidae, Colydiidae, Cucujidae, Cryptophagidae, Lathridiidae, Mycetophagidae, Parnidae, Heteroceridae; Dr. Bernhauer with our Staphylinidae, Mr. Bickhardt with our Histeridae, M. Lesne with our Bostrichidae, Herr Schenkling with our Cleridae, Mr. Creighton-Wellman with our Meloidae, Herr Borchmann with our Lagridae and Aleculidae, Herr Krekich-Strassoldo with our Anthicidae, Mr. Maulik with our Chrysomelidae Cryptostomes, Mr. Gahan with our Longicorns, and Mr. Marshall with our Curculionids. Dr. Jordan has worked out all our Anthribiidae during the year. In addition to the above specialists who deal with our collections in certain groups as a whole, Dr. Kolbe is working out the Carabidae, Dr. d'Orchymont the Hydrophilidae, Herr Schenkling the Cleridae, Erotylidae and Endomychidae, Herr Wichmann the Scolytidae and Dr. Wagner the Apioninae of the Abor Expedition; while the Lampyridae of the Expedition have been named by M. Olivier and the remaining Malacodermata, together with Ptinidae, Bruchidae and Anthicidae, by M. Pic.

**Lepidoptera.**—Captain Evans has worked out the butterflies of the Abor Expedition. He has also rearranged our collection of Satyrinae. During his visit to Calcutta further progress was made with the rearrangement and cataloguing of the Hesperidae, all identifications of which he checked last year. Examples of several Bornean species of Lycaenidae have been sent to Mr. Moulton for examination.

**Diptera.**—The whole of the collection of Diptera has been rearranged and an effort is now being made to catalogue it. Mr. Brunetti

continues his fruitful researches upon it and it is still growing rapidly. Dr. Kieffer is still working on our Chironomidae and Cecidomyidae, Miss Ricardo on our Tabanidae, Dr. Lichwardt on our Dolichopodidae and Nemestrinidae, Professor Bezzi on our Sapromyzidae and Dr. Speiser on our Diptera Pupipara. Mr. Edwards has recently undertaken work on our Culicidae.

**Thysanoptera.**—Our collection of Thrips is still with Mr. Bagnall.

**Rhynchota.**—Mr. Distant continues to return specimens to us as he names them. Mr. Rothschild has our Polyctenidae, and Mr. Van de Goot our Aphidae. We are still in communication with Mr. Green about Coccidae and with Mr. Crawford about Psyllidae."

### *III.—Public Galleries.*

There can be no doubt that the public galleries of the Zoological Section should be entirely re-arranged and renovated, if they are to be brought up to the level now demanded of museums in Europe and America. In order to undertake this work, however, it would be first necessary that an entirely new set of exhibition-cases be provided. This would mean the expenditure of many thousands of pounds and if it were to be undertaken in our present financial position would entail the total extinction of our scientific work. By considerable sacrifice of other interests we might possibly afford to buy one or two modern cases: these would make the rest look extremely shabby and the general effect in the galleries would be, for many years to come, incongruous and even less satisfactory than the present condition of affairs. I estimate the cost of placing the zoological galleries in a satisfactory condition on an average a lakh of rupees a gallery, that is to say, about six lakhs altogether.

On my deputation to Monaco last March I took the opportunity to examine with very great care the fittings, etc., of the new Oceanographical Museum there. From the report submitted to the Trustees on my return I may quote the following paragraph:—

> "The actual exhibits of marine animals in the Monaco Museum are much less extensive than those in our own galleries: with few exceptions, they are no better preserved: their scientific interest is no greater and their arrangement in the cases is, from a student's point of view, less satisfactory in that it renders it more difficult to find the specimens of any one group. But the general effect from an artistic point of view is beyond comparison with that of any scientific gallery in the Indian Museum, for the educational appeal of a museum gallery lies almost as much in the environment of the specimens as in the specimens themselves."

## *IV.—Field Work.*

Mr. B. L. Chaudhuri visited Chaibassa in May 1912, in order to make enquiries about the distribution of land tortoises in that district. Although he did not obtain specimens, he was able to arrange with officers stationed at Chaibassa that further enquiries should be made. These resulted in the acquisition of a specimen of an interesting new species of *Geoemyda* (*Rec. Ind. Mus., Vol. IX, Part 2*).

In April 1912, Mr. Gravely made a tour in the Satara and Rathnagiri Districts in the Western Ghats, accompanied by Mr. S. P. Agharkar, Lecturer on Biology, Elphinstone College, Bombay. The object of this tour was to investigate the life history of the freshwater medusa *Limnocnida indica* and also to study the distribution of the freshwater fauna on the two sides of the Ghats. A number of interesting facts were noted and valuable specimens obtained in connection with both enquiries and much material of a miscellaneous nature was acquired. Two papers in the "Records of the Indian Museum," *viz.*, Messrs. Gravely's and Agharkar's "Notes on the habits and distribution of *Limnocnida indica*" and my own account of the freshwater sponges of the Malabar zone, are founded wholly or in part on the results of this tour.

Mr. Gravely also spent a few days in February 1913 in Chaibassa in order to search for *Limnocnida* in the streams of that district, which resemble those of the Western Ghats in many respects. He obtained no satisfactory evidence of the occurrence of the medusa in Chota Nagpur, but collected some interesting sponges and other specimens.

In the same month Mr. Kemp made a tour on the Indian shores of the Gulf of Manaar, for the first part of which he was accompanied by Dr. J. R. Henderson, Superintendent of the Government Museum, Madras, who assisted in a most generous manner with his deep knowledge of the marine fauna of the district. The results are of importance as illustrating the extraordinary richness of the Crustacean fauna of these parts of the coast of India at which suitable conditions prevail. They have not as yet been completely co-ordinated and therefore will be best considered in next year's report.

While on leave I spent six weeks in Palestine and Syria. The object of the visit was, if possible, to trace the genera of sponges, coelenterates and polyzoa characteristic of the fresh waters of India and tropical Africa northwards up the Jordan valley, should they prove to have a distribution in any way similar to that of the Jordan fishes, whose African affinities have long been known. Collections of other invertebrates, more particularly the crustacea, worms and mollusca, were also to be made. The results are now being published in the "Journal of the Asiatic Society of Bengal" and a first set of all the specimens, including a considerable number of types, is being presented to the Museum.

## *V.—Research.*

The removal and re-arrangement of the collections have naturally interfered to some extent with the research work of the section, but a considerable amount has nevertheless been accomplished.

While in Calcutta I have continued my own work on the freshwater sponges of India and have completed an account of those collected in Palestine.

Mr. Kemp has completed and passed for the press his account of the Indo-Pacific Stomatopoda. He has also commenced work on the Onychophora and Crustacea Decapoda of the Abor Expedition.

Mr. Chaudhuri has worked out the fish collected by Mr. Kemp in the Abor country.

Mr. Gravely has continued his work on the Oriental Pedipalpi and Passalid beetles. He has completed a revision of the latter, which will be published shortly in the "Memoirs of the Indian Museum." In addition to entomological work, he has been through the flatworms of the order Temnocephaloidea in the collection and has described certain features of the anatomy of *Temnocephala weberi*, the only Indian representative of its family.

Mr. Ekendranath Ghosh, our new honorary assistant, has carried out, partly in the Museum and partly elsewhere, a detailed study of the anatomy of certain Rathouisiid slugs and also of the blind prawn *Typhlocaris galilea*.

Captain R. B. Seymour Sewell, Officiating Professor of Biology in the Calcutta Medical College, has continued in the Museum his investigations on the marine Copepoda. Apart from their theoretical importance, it is not too much to say that these investigations have added a new group to our collections, as there were no Indian species of the order named in our cases until Captain Sewell began to work out and arrange the Copepods in the townettings obtained by the "Investigator." As Surgeon-Naturalist he has also initiated the use of mid-water nets on board the survey ship. The results are already proving extremely rich in all groups of pelagic Crustacea, etc.

Mr. T. Southwell, Deputy Director of Fisheries, Bengal, has made use of our laboratories in his investigations into the parasitology of Indian fish and other vertebrates. The first paper in what we hope will be a long series on the Entozoa has been published by him in our "Records."

Mr. E. Brunetti has continued his studies on the taxonomy and nomenclature of the Diptera. Amongst other work he has described the collection made by Mr. Kemp on the Abor Expedition.

*List of Publications with special reference to Indian Zoology, from September 1912 to July 1913, prepared by B. L. Chaudhuri.*

## General.

ANNANDALE, N. . The African elements in the Freshwater Fauna of British India. (*Résumés des Communications, IX^e^ Congrès International de Zoologie, Monaco, Première Série, 29.*)

KEMP, S. W. . . Zoological Results of the Abor Expedition. Introduction. (*Rec. Ind. Mus., viii, 1.*)

,, ,, . . Preliminary Note on the Zoological Results of the Abor Expedition on the North-East Frontier of Assam. (*Résumés des Communications, IX^e^ Congrès International de Zoologie, Monaco, Troisième Série, 30.*)

LYDEKKER, R. . Biological Work in India. (*Nature, 90, 685.*)

## Protozoa.

PATTON, W. S. . Studies on the Flagellates of the genera Herpetomonas, Crithidia and Rhynchoidomonas. (*Sc. Mem. by Officers of the Med. and Sanit. Depts., Govt. of Ind., No. 57.*)

## Porifera (Sponges).

ANNANDALE, N. . Freshwater Sponges of the Malabar Zone. (*Rec. Ind. Mus., vii, 386.*)

,, ,, . Porifera of the Abor Expedition. (*Rec. Ind. Mus., viii, 67.*)

## Coelenterata.

GRAVELY, F. H., & AGHARKAR, S. P. Notes on the Habits and Distribution of *Limnocnida indica*, Annandale. (*Rec. Ind. Mus., vii, 399.*)

## Echinodermata.

CLARK, A. H. . . The Crinoids of the Indian Ocean. (*Echinoderma of the Ind. Mus., Part vii.*)

## VERMES.

LANE, C. . . *Trychostrongylus colubriformis* (*Giles*). (*Ind. Med. Gaz., xlviii, 129.*)

,, ,, . . *Agchylostoma ceylanicum*, A new Human Parasite. (*Ibid., xlviii, 217.*)

SOUTHWELL, T. . Some Notes on Cestodes and other Parasites in Indian Fish. (*Deptl. Rec., Dept. of Agri., Bihar and Orissa, No. 1, 1912.*)

,, ,, . On Some Trematode and Cestode Parasites from Fish. (*Rec. Ind. Mus., ix, 79.*)

STEPHENSON, J. . On a collection of Oligochaeta mainly from Ceylon. (*Spolia Zeylanica, viii, 251.*)

## CRUSTACEA.

HENDERSON, J. R. . A new variety of freshwater crab from Travancore. (*Rec. Ind. Mus., ix, 47.*)

SEWELL, R. B. S. . Notes on the surface-living Copepoda of the Bay of Bengal. (*Ibid., vii, 313.*)

,, ,, . The post-larval development of the Copepoda. (*Résumés des Communications, IX^e Congrès International de Zoologie, Monaco, Troisième Série, 24.*)

## MYRIOPODA.

GRAVELY, F. H. . Two New Species of *Scolopendridae*. (*Rec. Ind. Mus., vii, 415.*)

,, ,, . . *Scolopendridae* of the Abor Expedition. (*Rec. Ind. Mus., viii, 69.*)

HIRST, S. . . On a second Indian Species of the genus *Termitodesmus*. (*Ann. Mag. Nat. Hist., xi, 481.*)

## INSECTA.

ARROW, G. J. . . Notes on the Lamellicorn genus *Popilha* and descriptions of some new Oriental species in the British Museum. [*Ann. Mag. Nat. Hist., xii (8th Ser.), 38.*]

BELL, T. R. . . The Common Butterfly of the Plains of India. (*Journ. Bomb. Nat. Hist. Soc., xxii, 92.*)

BEZZI, M. . . Indian Trypaneids (Fruit-flies) in the collection of the Indian Museum. (*Mem. Ind. Mus., iii, No. 3.*)

BICKHARDT, H. . *Histeridæ* (Coleoptera) of the Abor Expedition. (*Rec. Ind. Mus., viii, 121.*)

BLAIR, K. G. . . Some new Species of Indian Tenebrionidae. (*Ann. Mag. Nat. Hist., xii, 50.*)

BRUNETTI, E. . . New Oriental Diptera. (*Rec. Ind. Mus., vii, 445.*)

,, ,, . . Notes on the Life History of *Aphiochæta ferruginea.* (*Ibid., 515.*)

,, ,, . . Diptera of the Abor Expedition. (*Ibid., viii, 149.*)

,, ,, . . New Indian *Empidae.* (*Ibid., ix, 11.*)

,, ,, . . Diptera Nematocera (excluding *Culicidae, Cecidomydae* and *Chironomidae.*) (*Fauna of British India series.*)

BUGNION, E. . . Le Termes Horni Wasm. de Ceylon. (*Revue Suisse De Zoologie, xxi, 299.*)

BURR, M. . . Dermaptera of the Abor Expedition. (*Rec. Ind. Mus., viii, 135.*)

CAMERON, P. . . On some new and other species of Hymenoptera in the collection of the Zoological Branch of the Forest Research Institute, Dehra Dun. (*Ind. For. Rec., iv, pt. ii, 1913.*)

CRAGG, F. W. . Studies on the Mouth Parts and Sucking Apparatus in the Blood-Sucking Diptera *Philæmatomyia insignis*, Austen. (*Sc. Mém., Offc. Med. Sany. Dept., Govt. Ind., No. 54.*)

,, ,, . . The Structure of *Hæmatopota pluvialis* (Meigen). (*Ibid., No. 55.*)

,, ,, . . Some Observations on the Morphology and Mechanism of the parts in the *Orthorrapha.* (*Ibid., No. 58.*)

,, ,, . . Studies on the mouth parts and sucking apparatus of the blood-sucking Diptera *Lyperosia minuta*, Bezzi. (*Ibid., No. 59.*)

CRAWFORD, D. L. . Indian *Psyllidae.* (*Rec. Ind. Mus., vii, 419.*)

DISTANT, W. L. . Descriptions of some new Homoptera. (*Ann. Mag. Nat. Hist., x, 361.*)

ENDERLEIN, G. . Zur Kenntnis Orientalischer Ortalinen und Loxoneurinen. (*Zool. Jahr. Abt. System., Band xxxiii, 347.*)

EVANS, W. H. . Lepidoptera of the Abor Expedition. (*Rec. Ind. Mus., viii, 61.*)

FAWCETT, J. M. . Mimicry in Silk-Worm Moths. (*Journ. Bomb. Nat. Hist. Soc., xxi, 89.*)

FRIESE, H. . . Neue Bienenarten. Von Ceylon. (*Deutsche Entom. Zeit., Heft i, Jahrgang 1913, 49.*)

GRAVELY, F. H. . Preliminary Account of a revised Classification of Indo-Australian *Passalidae.* (*Journ. As. Soc. Beng., viii, 403.*)

GREEN, E. E. . . Notes on the collection of Coccidae in the Indian Museum. (*Rec. Ind. Mus., ix, 1.*)

,, ,, . . On a Stridulating Reduviid Bug (*Physorhynchus linnaei*). (*Spolia Zeylanica, viii, 299.*)

,, ,, . . Dragon flies capturing Butterflies. (*Ibid., 299.*)

,, ,, . . On some aberrations of Ceylon Butterflies. (*Ibid., ix, 1.*)

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# ZOOLOGY.

## II.—ECONOMIC ZOOLOGY.

### PART I.—AGRICULTURAL ENTOMOLOGY.

BY

A. J. GROVE, M.Sc.,
*Officiating Imperial Entomologist.*

**Pusa Research Institute.**—The investigations into the life-history and biology of injurious and useful insects were continued, the following being specially studied:—

1. Indigo Psylla { *Psyllopa punctipennis*, Crawford. (*Psylla isitis, Buck.*).
2. Painted Bug, (*Bagrada picta*,. Fabr.).
3. Anar Butterfly (*Virachola isocrates*, Fabr.).
4. Termites, (*Termes* spp.).
5. Cotton Bollworms:
   (*a*) *Earias fabia*, Stoll.
   (*b*) *Earias insulana*, Boisd.
   (*c*) *Gelechia gossypiella*, Saund.
6. Parasites of Cotton Bollworms:
   (*a*) *Rhogas lefroyi*, Ashm. Ms.
7. Beetles attacking stored grain:
   (*a*) *Calandra oryzæ*, L.
   (*b*) *Rhizopertha dominica*, F.
   (*c*) *Tribolium ferrugineum*, F. & T.
   (*d*) *Æthriostoma undulata*, Motsch.
   (*e*) *Silvanus surinamensis*, L.
8. Parasites of Castor Semilooper (*Ophiusa melicerte*, Dr.) and Cabbage White Butterfly (*Pieris brassicæ*, Linn.).
9. Sugarcane Fly (*Pyrilla aberrans*, Wlk.).
10. *Aleurodidæ.*

The investigation on Indigo Psylla which was taken up at the request of the Bihar Planters' Association was continued and an article on the results obtained was published in the *Agricultural Journal of India*, Volume VIII, Part I. The investigation into methods for the prevention of damage by insects in stored wheat has been taken up at the request of the Punjab Government and is being continued. The investigation is specially in connection with the Wheat Elevator which is to be erected at Lyallpur. The Cotton Bollworms (*Earias* spp. and *Gelechia* sp.) and their parasite (*Rhogas lefroyi*) have received very close attention this year with the idea of obtaining more accurate information of the relation between the parasite and its host, careful statistical records of the occurrence of the pest and its parasite having been kept.

Trials with European univoltine mulberry races have been continued. It has been found that the eggs are preserved quite satisfactorily if sent to a hill station for storage during the dormant period, this obviating the necessity of cold storage in a refrigerator which is very expensive. The hybridisation work with mulberry worms continues to give satisfactory results. Attempts have been made to make arrangements for the disposal of small quantities of eri cocoons produced by small rearers as the lack of some such arrangement has been a great obstacle in the way of extending the industry. Better organisation for the procuring of fresh disease-free seed is also wanted, and is under consideration.

The lac collections, with the exception of a few ranges, are now complete and the material collected is being arranged for submission to an Expert. The cultivation of lac for experimental and demonstration purposes has been continued.

In Apiculture attention has been mainly directed to obtaining fertilized queens from the European bees and experiments with the common Indian bee (*Apis indica*) in bar frame hives. The difficulties in the way of procuring fertilized queens are very numerous and although twenty-five queens were reared only two were successfully fertilized. However, a better understanding of the problem has now been obtained and further attempts will be made. The work with *Apis indica* was largely hampered by the lack of proper appliances, but these are being obtained, and the experiments will be continued.

Observations on peach flies have been continued by the Imperial Pathological Entomologist.

**Provincial Departments.**—In Madras the investigations upon the Deccan Grasshopper (*Colemania sphenerioides*) were continued. The observations included the study of parasites and other natural enemies, and the effect of deep ploughing upon the egg masses. A method for preventing damage to stored tobacco by the Cheroot Beetle (*Lasioderma*

*serricome*) has been devised. Exotic cottons were again considerably damaged by the Cotton Stem Weevil (*Pempheres affinis*) and various experimental methods were tried, but with little success owing to the lack of knowledge of the life-history of the insect. A method was devised for preventing the collecting pots on toddy palms from the depredations of flies. Other pests dealt with included:—

*Stenachroia elongella*, Hmps.
*Spodoptera mauritia*, Bdv.
*Nymphula depunctalis*.
*Euxoa segetis*.
*Azygophleps scalaris*.
*Antestia cruciata*.
*Leptocorisa varicornis*.
*Achæa melicerta*.
*Euplexia conducta*.
*Udaspes folus*.
*Earias insulana*, *Earias fabia*, *Gelechia gossypiella*, *Stagmatophora coriacella*, *Dysdercus cingulatus*, *Oxycarænus* sp., *Lecanium nigrum*.
*Chilo simplex*.
*Diatræa* sp.
*Aleurodes bambusæ*.
*Epacromia dorsalis*.
Kumblihulas.
*Pundaluoya simplicia*.
*Odontotermes* sp.
*Alcides leopardus*.

In the United Provinces methods of preventing damage to potatoes by the potato moth (*Phithorimæa operculella*, Zell.) have been demonstrated. Observations have been carried out on the appearance of the parasite (*Rhogas lefroyi*) of the Cotton Bollworm (*Earias fabia*) in Bhindi and Cotton. Other pests dealt with included the Dusky Cotton Bug (*Oxycarænus lætus*, Kirby), the Cotton Leaf-roller (*Sylepta derogata*, F.) and the Rice Bug (*Leptocorisa varicornis*, F.). Demonstrations of methods of controlling insect pests were given at the Agricultural Shows with the help of show-cases and magic lantern lectures.

In Mysore, Green Bug of Coffee (*Lecanium viride*), insects attacking stored grains, and *Amsacto albistriga* have engaged attention.

In Bengal, the following pests have been investigated:—

Rice Hispa (*Hispa œnescens*).
Rice Swarming Caterpillar (*Spodoptera mauritia*).

Mango Hairy Caterpillar (*Cricula trifenestrata*).
Tobacco Caterpillar (*Prodenia litura*).
Rice Caseworm (*Nymphula depunctalis*).
Rice Bug (*Leptocorisa varicornis*).
Jute Semilooper (*Cosmophila sabulifera*).
Jute mite (*Tetranychus* sp.).
Bihar Hairy Caterpillars (*Diacrisia obliqua*).
Moth Borer (*Chilo simplex*).
White moth borer (*Scirpophaga auriflua*).
Large brown cricket (*Brachytrypes achatinus*).
Mango shoot borer (*Alcides* sp.).
White Weevil (*Myllocerus* sp.).
Litchi mite (*Eriophyes* sp.).

In Burma, experiments with mulberry silkworms were not successful owing to the place in which they were reared being unsuitable. Among the crop-pests studied were the Swarming paddy caterpillar (*Spodoptera mauritia*), the Paddy caseworm (*Nymphula depunctalis*, the Paddy stem borer (*Schœnobius bipunctifer*), Mango weevil (*Cryptorhynchus gravis*, F.) and fruit flies. The effect of spraying with lead Arseniate for Chafer Beetles defoliating Gold Mohar trees was tested and also the use of light traps.

In the Punjab, attention has been specially directed to the Moth borer in Cane (*Chilo simplex*, Butl.), the cotton bollworm (*Earias* spp.) and its parasite (*Rhogas lefroyi*), the introduction of mulberry silkworm rearing among the Zemindars and testing of the effect of $SO_2$ and $CO_2$ upon wheat "weevil." With the moth borer (*Chilo simplex*) cutting out of the "dead hearts" has been found very effective in checking the damage done by the borer. The parasite (*Rhogas lefroyi*) of the cotton bollworms (*Earias* spp.) was successfully established in breeding plots at Lyallpur and parasite boxes distributed. The effect of sulphur dioxide is detrimental to the germinating capacity of the wheat and also bleaches it, though effective in killing the "weevil." The effect of $CO_2$ still requires further investigation as it is not effective in all cases upon the "weevil" and in some cases affects the germinating capacity of the wheat.

In Bombay, the chief pests dealt with were the leaf roller on Til (*Antigastra catalaunalis*), stem borer (*Chilo simplex*) in Jowar, Gram caterpillar on Tur (*Chloridea obsoleta*) and grubs attacking cotton.

In the North-West Frontier Province, attention has been specially directed to determining whether the Peach fruit fly is present there and it has been found that it appears rather late in the peach season, earlier fruits being completely free, but peaches left on the trees after

August 30th were affected by maggots. Peach Aphides have also proved a serious pest. Trap crops of Maize for sugarcane borer (*Chilo simplex*) have been very successful.

In the Central Provinces, experiments were made with the Maize as a trap crop for sugarcane borer.

In Bihar and Orissa the campaign against the Greasy Cut-worm (*Agrotis ypsilon*) was again successfully carried on. Experiments with storing potatoes against damage by Potato moth (*Phthorinia operculella*), demonstration godowns being started at various places.

In Baroda, methods of checking "Katra" (*Amsacta* spp.), Sesamum stem borer (*Oberea* sp.) and Cotton Bollworms (*Earias spp.*). Arrangements were made to commence the cultivation of lac on Babool trees.

**The Indian Tea Association.**—The Entomologist has been principally engaged in the study of Mosquito Blight on tea. Experiments have been made on the treatment of Mosquito blight, Red spider and various other insect pests of tea and the investigation of their parasites.

**Southern Indian Planters' Association.**—Experiments have been made in co-operation with the Government Entomologist, Madras, to investigate the rôle played by bees and other insects in the fertilization of coffee. *Heterasia cingalu* was found damaging tea in Nilgiri, Wynaad district. Experiments with Mosquito blight on tea were continued. *Lecanium viride* (Green bug) made its appearance in Coorg and Mysore.

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## II.—ECONOMIC ZOOLOGY.

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### PART II.—FOREST ENTOMOLOGY.

BY

C. F. C. BEESON, B.A.,*

*Forest Zoologist.*

**Sal investigation.**—The work has been confined to the United Provinces; Dr. A. D. Imms, Forest Zoologist, made a short tour in the *sál* forests of the Siwalik Division. The investigation of the late larva, the pupa and the imago of *Æolesthes holosericea* has now been completed.

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* Dr. A. D. Imms held the post of Forest Zoologist up to the 27th February 1913, after which date, until the close of the year, Mr. N. C. Chatterjee remained in charge of the office.

The study of the eggs and early larval stages is being continued. A large number of male and female imagines and pupæ of *Æolesthes holosericea* was found in a felled trunk of *Terminalia tomentosa* in the Hoshangabad Forest Division, Central Provinces.

Three Bombycid moths bred from the larvæ attacking *sál* leaves received from Pilibhit Forest Division mentioned in last year's report were identified by Sir George Hampson as *Euproctis scintillans*, Wlk., or a species close to it.

The Coccinellid larvæ reported last year as predaceous upon Monophlebus scale insects have been identified by Mr. J. Weise as *Macronocius indicus*, sp. nov.

**Lac investigation.**—The work of studying the parasites of Butea lac has made considerable progress and nearly 2,000 specimens of such parasites have been reared up to date. These are gradually being worked out by various specialists abroad. Touring was undertaken during the year in three Forest Divisions in the Central Provinces and in the Rewah State, for the purpose of obtaining information regarding the local conditions and the frequent causes of failure of the lac crop. A biological study of the lac insect itself is now nearly complete, and it is hoped that this will serve to correct many of the errors prevailing with reference to the insect, and will be useful as a work of reference for all interested in lac cultivation, seeing that a reliable account of it does not at present exist.

Insects of several families were bred out of lac during the year and some of them are still awaiting identification by various specialists. The Coleopterous parasites of lac have been identified by Mons. A. Grouvelle of Paris as follows:—

*Cathartus advena*, Wlk.
*Typhæa hercorea*, L.
*Cartodera asiatica*, Grouv.
*Holoparamecus kunzei*, Anbi.
*Crytophycus ceylonicus*, Mos.
*Silvanopsis Iyeri*, Grouv.
*Berginus maindroni*, Grouv.
*Tribolium ferrugineum*, F.

Specimens of Butea stick lac were received from various Divisional Forest Officers of the Central Provinces, United Provinces and of the Khandesh Division, Bombay, and parasites are being bred out of them. The study of these parasites and their bearing on the production and propagation of lac is being continued.

In the winter brood the female lac insect is fertilised by winged and wingless males, but in the summer brood only the wingless form has been observed.

*Indian Forest Records*, Volume IV, Part II, containing descriptions of the new parasitic Hymenoptera bred from lac, by the late Mr. P. Cameron, was issued from the press during the year.

**New species.**—Among the specimens identified for us by specialists during the year the following have been described as new species:—

*1. *Ceratopogon lignicola*, sp. nov. (Chironomidæ).

*2. *Plecia impostor*, sp. nov. (Bibionidæ).

*3. *Parapleciomyia carbonaria*, gen. et sp. nov. (Bibionidæ).

*4. *Clitellaria bistriata*, sp. nov. (Stratiomyidæ).

*5. *Systœchus nivalis*, sp. nov. (Bombylidæ).

*6. *Hœmatopota albofasciatipennis*, sp. nov. (Tabanidæ).

†7. *Guadaba maculata*, sp. nov. (Cicadidæ).

A number of new species have been discovered by Dr. Ch. Kerremans (Buprestidæ), H. Gebien (Tenebrionidæ), Mr. Durrant (Tortricidæ), Mr. E. Meyrick (Microlepidoptera), Mr. Julius Weise (Coccinellidæ) and Mons. Grouvelle (Claviccrnia), the descriptions of which are not yet published.

A Histerid beetle, *Platylister procerus*, Lew., collected at Dehra Dun, has hitherto been known from China only.

**Other investigations.**—(*a*) A species of Coccid attacking Chir pine in the Naini Tal Forest Division. The investigation was continued during the year, and a large part of the life-history of this insect has been ascertained. The insect has been sent to Professor R. Newstead for identification. Two species of Coccinellidæ, the larvæ of which are predaceous on these Coccids, have been determined by Mr. J. Weise as follows:—

1. *Exochomus uropygialis*, Muls.

2. *Nephus seocrini*, Ws.

(*b*) A study of the various species of termites found in the Indian forests. The work of collecting specimens of white-ants and notes relating to the damage done by them was continued, and specimens have been received from nearly all parts of India. A large number of specimens was sent to Professor Dr. F. Silvestri of Portici, Italy, for identification, but the work has been delayed by Dr. Silvestri's absence from Italy.

(*c*) Ipidæ attacking Blue pine (*Pinus excelsa*) and Chir pine (*Pinus longifolia*) in the Chakrata Forest Division. Dr. A. D. Imms, Forest

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* E. Brunetti—Indian Museum Records, Volume VII, Pt. V.

† W. L. Distant—Ann. Mag. Nat Hist., Volume X.

Zoologist, inspected the affected areas on a short visit in October 1912. The damage done was due to the following species:—

(1) *Tomicus longifolia*, Steb.
(2) *Polygraphus longifolia*, Steb.
(3) *Polygraphus major*, Steb.
(4) *Polygraphus minor*, Steb.
(5) *Scolytus deodara*, Steb.

Remedial measures were carried out in infested areas, but the effect of these is not yet observable.

**Damage reported during the year.**—(*a*) Caterpillars of Noctuid moth *Ophiusa tirrhaca*, Cram., and of Pyralid moths *Chalcidoptera straminalis*, Guer., and *Macalla moncusalis*, Wlk., attacking *sál* trees in the Morha Range of Kheri Forest Division.

There is no previous record of *Ophiusa tirrhaca*, *Cram.*, and *Chalcidoptera straminalis*, Guer., attacking *sál*.

(*b*) Ipidæ attacking *sál* trees in the Buxa Forest Division, Bengal.

(*c*) Caterpillars of a Pyralid moth belonging to the genus *Euzophera* or a closely allied one, attacking cones of Chilgoza pine in Zhob, Baluchistan.

(*d*) Coccids attacking Kail (*Pinus excelsa*) in Kamraj Forest Division, Kashmir State. It is believed that further observations will prove this attack to be similar to the one in Naini Tal Forest Division. It has also been noted to occur to some extent in Jaunsar, United Provinces.

(*e*) Bruchid beetles of the genus *Bruchus* attacking stored seeds of *Albizzia Lebbek* sent by the Sylviculturist.

(*f*) Microlepidopterous caterpillars attacking *sál* seeds in the Nowgong Division, Assam.

(*g*) A Lamiid beetle (*Glenea Spilota*, Thoms.) attacking Semal saplings (*Bombax malabaricum*) in the Kheri Forest Division, United Provinces.

(*h*) Caterpillars of a Microlepidopterous moth attacking Bamboo seeds in the North Thana Division, Bombay Presidency.

(*i*) Aphids attacking *Cryptostegia grandiflora* plants in Kangra Forest Division, Punjab.

Two species of Cleridae beetles predaceous on *Sinoxylon anale*, Les., and a variety of *Sinoxylon Crassum*, Les. (which attack Shisham, *Dalbergia Sissoo*, in Dehra Dun), have been identified by Dr. Schenkling to be *Tillus notatus*, Klug; and *Cylidrus cyaneus*, F.

**Miscellaneous.**—Help in the identification of various insects has been generously given by Sir George Hampson, Mr. G. J. Arrow, Mr.

C. J. Gahan, Mr. C. Morley, Dr. Malcolm Burr, Dr. Max Bernhauer, Dr. F. Silvestri, Mr. W. L. Distant, Mr. S. Hirst, Mr. E. Meyrick, Mr. G. Lewis, Mr. E. Brunetti, Dr. Ch. Kerremans, Mons. A. Grouvelle, Mr. Meade Waldo, Mr. J. Weise, Mr. Gebien, Dr. Schenkling, Dr. K. Jordan and others.

*List of Publications on Economic Zoology.*

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DEPARTMENT OF AGRICULTURE, ASSAM. — Leaflet in English and Khasi on *Paintaphil*, a rice pest.

DEPARTMENT OF AGRICULTURE, BENGAL. — Leaflets on:—

1. Pests of Sann hemp and how to check them.
2. The Jute Semilooper.
3. The Rice Stem-borer.

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| | Leaflet in English and Canarese on the Flies spoiling toddy in South Canara. |
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| HOWLETT, F. M. | . Yellow Fever and Mosquitos. (*Agri. Journ. of India, October, 1912.*) |
| INDIAN TEA ASSOCIATION. | The Sandwich Caterpillar. (*The Quarterly Journ., Indian Tea Association, 1912, Part 1.*) |
| KASARGODE, R. S. | . Two recent Agricultural Pests. (*Poona Agri. College Magazine, iv, No. 3, January, 1913.*) |
| LEFROY, H. M. . | . The Psylla Disease of Indigo in Bihar. (*Agri. Journ. of India, January, 1913.*) |
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| MISRA, C. S. . | . Cultivation of Lac in the Plains of India. (*Bull. No. 28, Agricultural Research Intitute, Pusa.*) |
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# VETERINARY SCIENCE.

BY

MAJOR J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S.,

*Imperial Bacteriologist, Muktesar.*

In compliance with the programme of research work approved for the year 1912-13, the following investigations were carried out:—

**Rinderpest.**—A series of experiments were made to discover more economical methods of manufacture and improved technique. The details have been submitted for publication in Memoir form.

Many experiments were made on the value of drug treatment in Rinderpest. This investigation is being continued. These experiments, so far, have given negative results. Many drugs and antiseptics were administered to infected cattle, but none had much appreciable influence in the course of the disease.

The Permanganate of Potash treatment, advocated by Major Walker, C.I.E., and under trial in the Punjab, proved to have no beneficial effect when administered to susceptible cattle.

**Surra.**—Further experiments were conducted on the treatment and transmission of Surra.

An attempt was made during the monsoon to carry out an investigation on certain questions connected with the transmission of Surra, by means of biting flies, on the Kathgodam-Ranikhet Road. The investigation was commenced, but had to be abandoned as there was no one available to continue the work. A further attempt is being made during the present year to continue this research with the aid of the Government Entomologist.

The Annual Report of the Bacteriological Laboratory in the Colony of Mauritius, for 1911, contains a report on the good results obtained in that Colony by the Holmes method of treatment for Surra. The results obtained on Bovidæ proved excellent. Of horses treated, 52·9 per cent. were cured.

The Divisional Veterinary Officer, Burma Division, Maymyo, records successful results with the same treatment among infected mules in Upper Burma.

**Anthrax.**—An investigation was made on the value of the simultaneous inoculations of an Anthrax vaccine and Anthrax anti-serum as compared with the inoculations of an unmodified virus and anti-serum.

The results show that the method under investigation confers an active immunity, but is open to the same objection as when virus is used, namely, that the results are irregular and in some cases deaths occur after vaccination.

A paper on the subject is being prepared for publication.

**Hæmorrhagic Septicæmia.**—The investigation regarding the vitality of the organism outside the body was continued and is not yet completed. The results, so far, point to the prolonged vitality of the organism under certain conditions in soil and to the probability of infection being conveyed through fodder and water.

A number of experiments were made on the drug treatment of this disease. The Permanganate of Potash treatment was found of no value. The treated animals died in the same time as the controls. One drug experimented with has given a certain measure of success when administered in the early stages of the disease.

This investigation is being continued.

**Foot and Mouth Disease.**—From 1st October 1912 to March 30th, 1913, the Imperial Bacteriologist was deputed, in addition to his other duties, to assist the Foot and Mouth Commission sent from England to study certain features of the disease in India. The Commission worked at the Branch Laboratory, Bareilly.

In addition to the sanctioned programme of research, the following subjects received attention.

**Bursati.**—A study was made of the etiology and histology of this disease. A paper on the conclusions is being prepared for publication.

**Kumri.**—The investigation of this disease was continued, but as yet no positive results have been arrived at. The disease is one which requires investigation at the seat of outbreaks and this cannot be done with the present staff.

## Research from Veterinary Colleges and Provincial Laboratories.

**From the Camel Specialist.**—Mr. Leese continued his investigations into diseases of the camel and, in particular, the treatment of Surra. The results have been published as a Memoir of the Department of Agriculture, Veterinary Series, Vol. I, No. 3.

**Bengal Veterinary College.**—Mr. Ganguli, House Surgeon, and Mr. Mitter, Lecturer on Pathology, recorded the presence in Bengal of *Filaria Immitis* in dogs. Mr. Mitter further records the presence of Gastrodisc in an Indian Zebu and describes the occurrence of *Gnathostomum Spinigerum* in India.

*A List of Papers published during 1912-13 bearing on Indian diseases.*

BRANFORD, R. . . Trypanblau in the Treatment of Canine Piroplasmosis as occurring in India. (*Vet. Journ., Vol. 68, pp. 643—648.*)

CROSS, H. E. . The preparation of Anti-Rinderpest Serum by the injection of virulent Artificial Peritonial Fluid. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 206—215.*)

DUTT, J. F. D. . . Successful treatment of Tetanus with Liquid Ferri Perchloride Fort B. P. (*Vet. Journ., No. 452.*)

GANGULI, H. C. . Filaria Immitis in Calcutta. (*Vet. Rec., No. 1264 of 1912.*)

GILLET, E. S. . . Hæmorrhagic Septicæmia in a horse. (*Journ. of Comp. Patho. & Thera., Vol. XXV, pp. 321.*)

HARTLEY, P. . . On the Immune Bodies occurring in Rinderpest Immune Serum. Part I—The Preparation of the Rinderpest Immune Bodies by Dialysis of the Immune Serum. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 216—230.*)

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HOLMES, J. D. E. . The Treatment of Surra in Horses by means of Arsenic and its Derivatives. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. I, pp. 1—48.*)

,, ,, . The Cure of Surra in Horses by the Administration of Arsenic. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. I, pp. 49—72.*)

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HOLMES, J. D. E. . Reports on Experiments carried out to test the susceptibility of Cattle for several districts and on Improved Methods of Rinderpest Serum Preparation. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. II, pp. 98—205.*)

" " . Further Testings of the H. S. anti-Serum and Vaccine on Bovines and Equines. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. III, pp. 242—247.*)

" " . The Practical Value of Authrax anti-Serum and Vaccines. Preliminary Report. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. IV, pp. 248—271.*)

" " . A Note on Elements resembling Spirochætes found in the Blood of Man and Animals. (*Mem. Indian Civil Vety. Dept., No. 3, Pt. IV, pp. 272—276.*)

" " . Anaphylaxis in the larger Animals. (*Mem. of the Dept. of Agr., Vety. Series, Vol. I, No. 1.*)

" " . Salvarsan in the Treatment of Surra in Horses, Dogs and Rabbits. (*Mem. of the Dept. of Agr., Vety. Series, Vol. I, No. 2.*)

" " . A Note on some Interesting Results following the Internal Administration of Arsenic in Canker and other Diseases of the Foot in Horses. (*Agr. Bull. No. 32.*)

" " . A Note on the M'Fadyean Staining Reaction for Anthrax Bacilli. (*Arg. Bull. No. 36.*)

" " . Some cases of Surra treated in the field and in the Laboratory during the Autumn of 1911. (*Mem. of the Dept. of Agr., Vety. Series, Vol. II, No. 1.*)

" " . A Description of the Imperial Bacteriological Laboratory, Muktesar: its Work and Products, English, Urdu and Hindi editions. (*Pamphlet.*)

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| ,, ,, . | . A Brief Résumé of our knowledge of Rabies. (*Calcutta Med. Journ., Vol. VII, No. 5.*) |
| ,, ,, . | . A Résumé of our knowledge on the occurrence of Gnathostomis Spinigerum in India and its relation to a similar parasite found in man. (*Vet. Journ., December 1912.*) |
| ,, ,, . | . Further Note on a Gastrodisc (?) from an Indian Zebu. (*Vet. Journ., March 1913.*) |
| ,, ,, . | . Filaria Immitis in Calcutta. (*Bull. de la Soc. de Path. Exot., Tome V, No. 9.*) |
| ,, ,, . | . Descriptive Catalogue of Pathological Specimens in the Bengal Veterinary College Museum. (*Bengal Government Publications.*) |
| OLIVER, E. W. . | . Note on Surra. (*Bull. No. 27 of Dept. of L. & A. of Agra & Oudh.* |
| ,, ,, . | . Note on the Foot and Mouth disease of cattle in United Provinces. (*Bull. No. 24 of Dept. of L. & A. of Agra & Oudh.*) |
| WALKER, G. K. . | . Rinderpest and Hæmorrhagic Septicæmia with Permanganate of Potash. (*Journ. of Comp. Path. & Thera., Vol. XXV.*) |
| WHITMORE, A. . | .An Account of a Glanders-like disease occurring in Rangoon. (*Parasitology, Vol. XIII, No. 1.*) |

## MEDICAL RESEARCH WORK.

*Work done under the auspices of the Indian Research Fund Association during 1912-13.*

The following is a brief review of the work done under the control of the Scientific Advisory Board of the Indian Research Fund Association during the year 1912-13. The more important subjects dealt with were (1) Cholera, (2) Kala Azar, (3) Yellow fever, (4) Malaria.

(1) *Cholera.*—Major E. D. W. Greig, I.M.S., Assistant Director, Central Research Institute, Kasauli, was placed on deputation from the 26th January 1912 to conduct an enquiry into the disease. Calcutta was fixed as the centre of the investigation. His researches at Calcutta and at Puri at the time of the Car festival (which was attended by an outbreak of cholera) have already yielded results of very great interest and practical importance. He has demonstrated the important part played by the human "carrier" in the spread of infection.

(2) *Kala Azar.*—A sub-committee consisting of Surgeon-General Bannerman (President), Lieutenant-Colonel Donovan, Major Christophers and Dr. Bentley was formed to direct the enquiries. Captain F. P. Mackie, I.M.S., Captain Patton, I.M.S., and Dr. V. T. Korke were deputed for the purpose of carrying out the investigations. Captain Mackie has devoted most of his attention to Bengal and Assam and is at present working in the latter province. Captain Patton has been engaged chiefly in laboratory experiments investigating the insect transmission theory of the disease. Dr. Korke has devoted his time to the epidemiology of Kala Azar, studying the distribution and modes of spread of the disease in the endemic areas of Royapuram in Madras City. Their labours have added considerably to our knowledge of the disease, but much yet remains to be done.

(3) *Yellow fever.*—Major S. P. James, I.M.S., was deputed to study yellow fever in its endemic area with the object of drawing up a report as to measures for averting the danger of the introduction of the disease into India, and for stamping out the disease should it appear. Major James has returned and submitted an interesting and valuable report, which contains the opinion that the opening of the Panama Canal will not, immediately at any rate, increase the present danger of India becoming infected with yellow fever. Major James, however, points out that the increase in "local" trade that can be expected to follow the opening of the canal may modify materially the present distribution of the disease and so introduce new dangers which cannot at present be foretold. He advances reasons which lead him to believe that the main

trade routes are unlikely to be materially altered, and as they exist at present the chances of importing infected mosquitos are not considerable.

Meanwhile *stegomyia* surveys have been undertaken in Calcutta, Bombay, Madras, Karachi and Rangoon. The results demonstrate how widely diffused and universally present in the ports of India is *Stegomyia fasciata*, the mosquito responsible for the spread of yellow fever.

(4) *Malaria.*—On the inauguration of the Indian Research Fund, the Malaria Committee, already in existence, was made a sub-committee under the Scientific Advisory Board. Several grants were made to local Governments by the Research Fund during the year to enable them to carry out anti-malarial measures or surveys. Much useful work was done in this connection during the year.

On the recommendation of the Scientific Advisory Board grants were made by the Indian Research Fund during the year in aid of—

(1) Entomological Research in Pusa and at the King Institute of Preventive Medicine, Madras.

(2) Experiments on the subject of plague disinfection of rice in bulk which are being carried out at Parel, Bombay.

(3) Investigations into the chemical composition of milk in the United Provinces.

(4) The supply of scientific literature to brigade laboratories and for the Central Malaria Bureau.

(5) The extension and improvement of the Central Research Institure at Kasauli.

# APPENDIX.

## REPORT ON THE SCIENTIFIC AND TECHNICAL INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED 30th JUNE 1913.

BY

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The scientific and technical investigations which have been in progress at the Imperial Institute for India during the year ended 30th June 1913 are as follows:—

(1) **Opium and other drugs.**—A comprehensive report has been furnished to the India Office on the composition of Indian opium.

A sample of wild *Podophyllum Emodi* rhizomes from the North-West Frontier Province was of very satisfactory quality. These rhizomes would be considerably more valuable commercially than those of *Podophyllum peltatum* if they could be used in European medicine. At present, however, *P. Emodi* is not official in most pharmacopœias and can therefore only be employed for unofficial preparations.

An investigation of the alkaloids of *Peganum Harmala* seed has been carried out by Professor W. H. Perkin, Jr., with material supplied through the Imperial Institute. Copies of three papers on the subject, which he has contributed, in conjunction with Mr. R. Robinson, to the Chemical Society of London, are attached.

(2) **Essential Oils.**—A further report was furnished on the oil of "Nepal sassafras" or "Nepal camphor wood," *Cinnamomum glanduliferum*. The oil contains safrole, and might possibly be used as a substitute for sassafras oil, for which, however, there is only a limited demand, or as a source of safrole, or as a perfume for cheap soaps. For the latter purposes it would have to compete with camphor oil and would only realise about 4*d*. to 6*d*. per lb.

The scientific results of this investigation, conducted at the Imperial Institute, were communicated by Dr. S. S. Pickles to the Chemical Society of London, and a copy of his paper is attached.

A consignment of cuscus roots (*Vetiveria zizanioides*) from Trichinopoly was examined in order to determine the value of the material as a source of vetiver oil. The roots were found to be of inferior quality,

giving a low yield of somewhat abnormal oil, so that it was doubtful whether they would be readily saleable in Europe.

Samples of Kalamet wood (*Mansonia Gagei*) from Tenasserim contained very small amounts of volatile oil which could only be extracted with difficulty. Unless wood containing a higher percentage of oil can be obtained the material would probably not be of value for export.

Five samples of Cochin lemon-grass oil were examined, and suggestions were made as to the reasons for the change which has recently occurred in the character of the lemon-grass oil shipped from Cochin.

(3) **Turpentine Oil.**—Samples of turpentine oil from *Pinus excelsa* and *P. Khasya*, prepared by the Forest Chemist at Dehra Dun, were forwarded for examination. The oil of *Pinus excelsa*, after re-distillation to remove the yellow colour, was found to be equal in quality to the best grades of French and American turpentine oil. The oil of *Pinus Khasya* appears to be a mixture of terpenes, and would probably be classed in the market with low-grade American oil.

(4) **Oils and Oilseeds.**—The investigation of Margosa fat was continued in order to ascertain whether its unpleasant odour could be easily removed. It was found that the odour is due to the presence of a compound of sulphur, which apparently cannot be removed by means of solvents or by any simple or inexpensive process; it disappears when the fat is treated with steam, but subsequently develops again. The commercial utilisation of Margosa seed in Europe therefore seems impracticable at the present time.

A sample of Raina seed (*Amoora Rohituka*) yielded 43·5 per cent. of a viscous yellow-brown oil which would be of fair quality for soap-making, and on this basis the seed was valued at about £9 per ton in the United Kingdom (April 1913). A sample of "Panang" kernels (*Calophyllum Inophyllum*) yielded 71·4 per cent. of oil of good quality for soap-making, and a firm of oilseed crushers stated that kernels containing as much oil as this should be worth £16 per ton in the United Kingdom (April 1913).

Several sardine oils from the Fishery Bureau, Madras, were examined and found to be suitable for the usual purposes to which fish oils are applied, *viz.*, leather-dressing and currying, and to a smaller extent for soft soap manufacture, tempering steel, admixture with paint oils, and jute batching.

(5) **Burmese Lacquer.**—Samples of "Thitsi" or Burmese lacquer, forwarded to the Imperial Institute in order to ascertain the possibility of finding a market for the product in Europe, were submitted to manufacturers, merchants and technical chemists, several of whom expressed considerable interest in the material and undertook to carry

out trials with it. Some of the experiments were still in progress at the end of the year, but the majority of the experts consulted considered that Thitsi could not easily be utilised in the United Kingdom as a varnish, owing to its slowness in drying under ordinary conditions. In order to get the lacquer to dry satisfactorily it is necessary to expose it to a damp atmosphere at 30° to 35° C. for three or four days. A large firm of cabinet-makers, however, reported that they could use Thitsi in place of Chinese lacquer, and they were accordingly furnished by the Imperial Institute with the names of firms prepared to export it from Rangoon.

(6) **Fish Waste.**—Three samples of fish refuse from the Fishery Bureau, Madras, were found to contain average quantities of nitrogen, phosphoric acid and fat, but rather less protein than is usually present in fish meals. The material should be readily saleable as a fertiliser or for the preparation of feeding-stuffs.

(7) **Cotton.**—Fifty-two representative samples of the different types of cotton grown in the Northern Division, Bellary, were very similar in general characters and were, on the whole, of satisfactory quality.

Ten samples grown on the Government Experimental Farm at Akola, Central Provinces, consisted of good clean cotton of very satisfactory growth.

Eight samples grown experimentally at Lyallpur in the Punjab were of satisfactory appearance and strength, and were valued at good prices.

Several samples of cotton from Burma, including native types, Cambodia and "kidney" cottons, were also examined during the year.

(8) **Fibres.**—Three samples of rhea ribbons were forwarded by the Fibre Expert at Dacca for examination. Only one sample was sufficiently prepared to be saleable in Europe, and this was valued at £25 per ton in London by a firm of fibre merchants who expressed a desire to receive consignments.

A fibrous bark, stated to be derived from a species of nettle found in Terai and on the lower slopes of the Himalayas, would be suitable for paper-making, but for this purpose it would probably not be worth more than £4 or £5 per ton in the United Kingdom. It was suggested that possibly a useful fibre could be prepared from the plant by submitting the freshly cut stems to a retting process like that employed in the case of jute.

Four specimens of jute, grown experimentally, were specially examined at the request of the Fibre Expert at Dacca, in order to ascertain the percentage of cellulose present, the tensile strength, and the length of the ultimate fibres.

Samples of *Malachra capitata* and *Urena lobata* fibres grown experimentally were submitted for examination by the Fibre Expert at Dacca. Both fibres were of excellent quality, and were valued in London at prices above those of "first marks" Calcutta jute. The merchants stated that they would be glad to receive consignments of these fibres.

A sample of wild plantain fibre from Burma was of very good quality and was valued at about £20 per ton in London with "fair current" Manila hemp at £22 to £22 10*s*. per ton; a subsequent sample was valued at £35 per ton in London (May 1913) with "fair current" Manila hemp at £33 per ton. Commercial experts were of opinion that the fibre would be suitable for fine spinning, and there is no doubt that it would be readily saleable in the United Kingdom.

A small consignment of Sida fibre forwarded by the Fibre Expert at Dacca was sold in London at £27 per ton. It was however valued at £28 to £30 per ton (July 1912) if shipped in commercial quantities.

(9) **Rubber.**—Six samples of Para rubber from Burma were well prepared and exhibited good physical properties. They varied somewhat in composition, the amount of caoutchouc present ranging from 90·0 to 94·3 per cent. They were valued at about 3*s*. 2*d*. to 3*s*. 4*d*. per lb. in London with fine hard Para at 3*s*. 4*d*. per lb. (April 1913).

(10) **Miscellaneous Official Enquiries.**—In addition to the foregoing reports, information was furnished and assistance rendered during the year to Indian Government officials in connection with various technical and commercial matters, including the following:—

The utilisation of rice.

The analysis of feeding-stuffs.

The use of bamboo pulp as a paper-making material.

The marketing of sandalwood.

The determination of prussic acid yielded by beans.

The cultivation of peas and beans in Burma.

The production of "synthetic" timber.

The preparation of jute fibre.

A number of other miscellaneous enquiries relating to Indian matters received from commercial firms and private individuals in India and in the United Kingdom were also dealt with during the year, information being furnished to the enquirers regarding food grains, oilseeds, turpentine, tanning materials, fibres, minerals and various other subjects.

A number of articles and short notices relating to Indian economic products and their exploitation were published during the year in the

"Bulletin of the Imperial Institute." The principal subjects dealt with were as follows:—

"The Improvement of Cotton in India."

"Lemon Grass Oils from India."

"Turpentine Oils from India."

"Wild Plantain Fibre from India."

"The Occurrence of Samarskite in India."

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